



DISSEMINATING INQUIRY-BASED SCIENCE
AND MATHEMATICS EDUCATION IN EUROPE

STARTING PACKAGE

EXAMPLES OF LEARNING UNITS FOR IBSE IN PRIMARY SCHOOL

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Preamble

This selection of units was designed to help Fibonacci partners start pre-school and primary science activities in the classroom with ready-to-use, turnkey material. However, these documents do not claim for perfection and should be mostly used as inspirational guidelines to design more extensive or complementary units on the same or other topics.

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Can Science and Technology Be Taught in Pre-School?

Pre-school is the preferred setting in which small children can, through experience, become familiar with objects, phenomena, processes and roles. However, teaching science and technology is not merely a matter of having children handle or “frequent” “scientific objects” or “technological objects”; each experience has to give rise to more specific knowledge, while the activities accomplished must effectively support the development of thought processes in the throes of being structured. “Teaching science and technology” also means ensuring access to an intellectual building process that leads to objective knowledge, a process that can and must be envisioned from the earliest stages of life.

This examples hereafter will help delineate that knowledge as precisely as possible and define a level of expression suited to the students’ age, while also suggesting situations and work methods that will make it possible to stir, observe and appropriately value the students’ evolving reasoning processes.

Learning about the world in pre-school is looking at one’s surroundings with curiosity and inventiveness, all the while “experimenting with the tools used in intellectual work”, which, ultimately, will enable students to reason, study occurrences and act on the world of matter and objects, to better understand, use and transform them.

One of the major objectives in early scientific education in pre-school is to bring students face-to-face with the “constraints of logical thinking” and, in so doing, to contribute to building the aforementioned intellectual tools.

Identifying the Intellectual Tools for Science in Primary School

The observations offered here are by no means intended as an all-encompassing view of the issue, but rather a framework for teachers in pre-schools and elementary schools, to help them organise the instruction they provide to their students, where one of the priority objectives is building the tools of thinking.

Relating to the Real World

At a time when the virtual is sometimes condemned as becoming overly significant, scientific education is clearly a preferred alternative. To characterise the type of relationship that the sciences keep up with the real world, we suggest distinguishing between events and scientific facts or phenomena.

The former clearly proceed from space and time: they take place somewhere and at a specific time, and are often the result of chance or circumstance.

The latter are general, and do not result from chance or circumstances. They depend neither on the will of those who produce or observe them, nor on place or time, but rather on experimental conditions. They can be reproduced by other experimenters, in other places and at other times.

That general, organised and reproducible nature is an important feature of the sciences, which can help teachers more clearly state the objectives of early scientific and technical education.

Impact on Language

“Learning about the world” activities make a very positive contribution to enhancing vocabulary and structuring syntax. To gain new and precise words requires experiencing what they express. Likewise, taking part in scientific and technological activities makes an effective contribution to building appropriate syntax, conveying the characteristics of science and technology.

Through them, and with the support of the teacher, whose renderings act as a model for the students, helping them gradually learn to use:

- logical, analogical, spatial and temporal connectors to express relationships between phenomena;
- explicit markers of generality (“always, every time that...”) or conditionality (“if...then...”);
- sentences often in the present tense, the subject of which is not the experimenter, but one of the parameters in the physical situation (“water changes form at 0°C” is different from “we froze water; we saw that the temperature was 0°C”).



How to proceed in pre-schools

Now that these reference points have been established, let us consider them with respect to the cognitive capabilities of pre-school children. First, it is certain that no student can have built up, in a stable manner, the general, structured “scientific thinking”, by the end of pre-school. The aim of this rapid overview is to help pre-school teachers identify the direction in which they can look to trigger positive changes in their students.

However, it is important to keep from thinking that because students are very young; they automatically are incapable of rendering ideas in a general and structured manner in pre-school. For, while the development of thought depends in part on children’s age, which makes it possible to learn specific things at specific times, it is also in large part conditioned by the activities conducted by the school. When students are given the opportunity and time to experience situations, take action and observe the effects of their actions, when they are called upon to copy, compare and achieve other effects, then they can, even when young, understand that, beyond their immediate and personal experiences, there exists something more general to understand.

We will see, through the few examples provided in this preamble and, more broadly throughout the entirety of this booklet, such an undertaking is possible, provided that the subject and the activities suggested are appropriate.

Spoken and Written Language

The same is true in the field of language: “Upon completing pre-school, [students] are able to come up with complex assertions and connect them to [...] explain a phenomenon.” To achieve this, language skills need to be evolved at the same time as scientific knowledge: “at this age, language is necessarily worked on in connection with an activity or a point in everyday life.” Rounding out this experience is the use of quality documentaries tailored to young children; they are an opportunity to bring the students in contact with language forms that are more appropriate than their own, and the meaning of which they are able to perceive thanks to having completed other activities and groped with the language they stirred.

In addition, from the very first year of pre-school, one of the main aims is to “help students learn the prime social functions of writing”. As they learn about the world around them, children are in an excellent position to explore the complex phenomenon of writing, with the written word (in the broadest sense) shown in different forms, each with its own specific function: a list (to keep from forgetting anything), a chart (to compare easily), a drawing (to describe an experience), a sentence (to report an observation or outcome), etc.

Drawing as an Example

When unprompted, children’s drawings have none of the features expected of a scientific drawing: they attempt to represent the object studied, but convey many aspects in abstract form. Beyond their often-clumsy contours, children’s drawings are more an expression of their experiences and highly charged in sentiment.

The evolution toward fully-realised drawings that could truly be referred to as scientific is long and complex, and will continue well beyond primary school. A first step back can, nonetheless, be made in pre-school thanks to the teachers’ requests. An instruction phrased as “Draw what we learned” will often lead to a more apposite representation of the object studied than “Draw what we did”, which is more likely to arouse a retelling of a moment in life.

The use of photography, a more flexible technique since the advent of digital processes, can provide a valuable contribution. A wide-range photograph on which the children can recognise themselves will tell of an experience shared, while a close-up of the object of study will reveal the significant factors in the situation. This comparison can lead to a distinction between the two complementary yet fundamentally different functions of photography. Beyond the photograph itself, the aim is to bring about changes similar to those stirred by the drawings: drawing objects rather than the children holding them; showing what is meaningful; producing several drawings where a phenomenon develops over a period of time, etc.

From action to intellectual elaborations in pre-school

Toward the properties of matter and objects

During their pre-school years, children are especially sensitive to the “power” they have on the world around them. When they handle objects, they are taking interest in themselves, their actions, feelings and abilities. Children tend



to take things apart, or even break them. This is not, in general, to look what is inside the object, nor necessarily out of ill-will, but simply to experience the power that they have on the object. Without going so far as to let children break equipment, there is indeed good to be found in leaving them extended time for undirected exploration which, sometimes, is enough in itself and already holds real intellectual activity, provided that it is finalised by an objective to be reached or a skill to accomplish. When the teacher feels it is possible, he may take whatever opportunities arise to embark on more complex intellectual elaborations, intended to convey to the students that, while they do have a certain degree of power on things, those things also have properties that they cannot control.

An Example on Handling Magnets

Through self-motivated trial and error, a child finds out that a magnet can “move” a paper clip through a table. He tells of his discovery, saying something like: “Look at what I can do”. Another child wants to try, but fails because his magnet is not strong enough. He forges on, without changing any of the experiment circumstances and ultimately loses interest in the phenomenon. The first child continues: “I am better than you”.

This anecdote was meant to illustrate behaviours frequently seen in pre-schools and suggest the following appropriate reaction from the teacher:

– helping the second child persevere in his attempts, without giving him “the” right answer, but rather stirring him to change the experiment conditions, by questioning him: “How about changing magnets? How about changing tables? How about changing paper clips?”;

at the same time, helping the first child, through the same types of questions, realise that some of the reasons for his success have nothing to do with him and that he can reproduce the phenomenon observed if he “understands”¹ the underlying reasons.

This example illustrates what “teaching science” in pre-school can mean. It means realising that the world exists apart from oneself and one’s will, and that it is partially intelligible. It means acting, in an imaginative and organised way, on an event before one’s eyes.

Cause-Effect Reasoning in Pre-School

One way of studying a phenomenon in pre-school is attempting to identify its causes and determining the consequences of a given modification (if the thickness of the table top increases, the magnet will ultimately fail to attract the paper clip). However, in pre-school, children do not clearly distinguish the causes of various consequences. This can be seen clearly in their first language constructs which, while officially similar to scientific assertions, often have some of the features of children’s thought: “Cats have claws to catch mice” or, if there is a draft, “The door is opening because the wind wants to come in”. Progress can be sought in this area over the long term by making use of the many situations, whether rooted in action or language, where the cause and the outcome can be seen unambiguously (“This object fell because the child pushed it; the child pushed the object, so it fell over”).

Later, in more complex situations, the teachers need to use exact wording, all the while successfully recognising the best-worded hypotheses from the children, for instance by taking them onboard themselves. Children also need to be able to progress by being immersed in assertions heard from reference adults, in a two-way or group situation.

The Limits of Simple Causality

The sciences are not a simple matter. Most often, phenomena depend on a whole set of causes, not always identifiable comprehensively and unequivocally.

Let us return to the cat example. It can catch mice, but this is not only because it has claws, but also because it can move slowly and silently, because it is capable of pouncing, running faster than a mouse, change directions quickly, etc. In short, an entire range of causes needs to be considered. More fundamentally speaking, scientists do not wonder why cats can catch mice, but rather what features make it particularly suited to catching small rodents.



Scientific questions are not always expressed in terms of “why”, but more often in terms of “how”, “under what conditions”, “what features”, etc.

Never aiming to formally impart concepts, it remains possible and beneficial to have children partially broach this complexity in their late pre-school years, based on situations encountered. Returning to the example of the magnets mentioned earlier, the teacher can help his students understand that the phenomenon depends on two variables and express this: “The magnet is not attracting the paper clip because it is not ‘strong’ enough”² or because the table is too thick”.

An Example to Summarise

A student falls after having slipped on a sheet of ice. Here are a number of different paths for recounting the event, trying to identify its causes and, lastly, deriving generalities from it. It can be reasonably stated that the last version, which goes the farthest, can be achieved by many children in their last year of pre-school.

- “I fell down, I slipped and I hurt myself”: the student recounts an event experienced.
- “This morning, there is ice in the courtyard and I slipped”: the event is framed in a specific time and place; the student realises the inklings of a relationship between the two events: the presence of ice and the fall, but the connector “and” is not the most appropriate.
- “I fell down because there is ice in the courtyard: the student establishes a cause-effect relationship and uses the logical connecting term “because”, to denote it.
- “I fell down because there is ice in the courtyard and because I was running»: the presence of ice is not the only cause for the fall.
- “If there is ice on the ground, if you run and if you don’t pay attention, then you might fall”: the conditions enabling a fall are stated; note that in pre-school, the use of the conjunction “when” instead of “if” in young children does not have a significant bearing.
- “There is ice in the courtyard, so it’s slippery”, or “It’s slippery because there is ice in the courtyard”: there is no more reference to the fall, but rather a characteristic of the ground as the cause-effect relationship is stated; the first person is discarded and the present tense used, denoting a statement that has become general.
- “Ice is slippery”: a general property of ice is stated, one that applies regardless of place and date; this is a statement of scientific fact.

Concluding

Teachers need to strive to bring about the transition between personal and immediate experience and the general and complex character of science and technology.

The transition is necessarily very gradual and cannot be completed during pre-school alone. Going back to the ice example, the transition between “I fell, I slipped, I hurt myself” and “There is ice on the ground and it’s slippery” can already be considered a significant step in first-year pre-school students. It may be that no further progress is possible... This is also true in drawing, where development remains very difficult before the end of the second year.

The chart hereafter summarises how reasoning should develop, how it should be expressed and how it should be depicted. The sequence may not be completed by the end of elementary school; in other words, these are long-term objectives, but still need to be clearly understood by pre-school teachers so that they can set their students on the right track. At the same time, they need to be able to take advantage of the most concrete situations encountered to encourage such developments.



Natural tendencies	Target development path
Childish reasoning ("Cats have claws so they can catch mice").	More or less elaborate cause-effect relationships: – "Cats can catch mice because they have claws"; – "Cats can catch mice because they have claws, know how to pounce, etc."
Interested in events – related to actual experience; – often subjective; – framed in time and space; – result from chance or circumstances. "Event-related" language – No logical connectors or inappropriate connectors ("and", "so that", etc.); – description of circumstances ("this morning", "in the courtyard"); – verbs often in the past tense ("I slipped"); – frequent use of the first person: the subject of the sentence is the child himself ("I can attract the magnet")	Interested in scientific fact – unrelated to personal experience; – objective; – unrelated to place and time; – dependent on experimental conditions, reproducible. Scientific language – Logical connectors present ("because"); – Explicit denotation of generality ("always, every time that"), conditionality ("if..."); – verbs in present tense ("the ice is slippery"); – use of the third person: the subject of the sentence is the object of study ("the magnet attracts the paper clip").
"Event-related" depictions – People, settings, details, colours etc. depicted, without any selection between what is significant and what is not; – a single drawing to represent the event.	Scientific depictions – Streamlined depiction; only the object of study is shown; selection of aspects to show, non-helpful details left out, etc.; – the number of drawings depends on what is scientifically significant.

Language and Learning about the World

Curiosity, Experimentation, Learning and Language

To achieve the aim of knowledge enrichment, the experiments offered in school to teach about the world need to be varied, of high-quality and authentic. Thanks to his observations and explorations, and the portrayals he is asked to produce or use, pre-school students build up a range of experiences to which they will be able to refer later and which will enable them to engage, with all the more confidence, in developing knowledge at more demanding levels.

The experiments are based on actual phenomena: an ice cube that melts, seeds that germinate, etc., and, rounding out that experience, depictions: photos of an iceberg, a book about plant life, etc.

The pre-school activities designed to introduce children to the world of living organisms and the world of objects and materials, responding to children's insatiable curiosity, are fruitful times for language development.

From unprompted – and often highly committed – exploration or observation to more structured inquiry, the children experiment with intellectual work instruments while also building up the language skills required to express



themselves and the handiness required to take action. While the children should be given whatever time necessary to perceive, act and feel, their vocabulary and syntax can only be enriched if their experiences are put in words, stimulated by the desire to communicate. The structure of their sentences becomes more complex when the subject matter becomes more specific.

The explanations required to gain perspective and exchange about the experiments help build a more rational depiction of the world.

In child/adult dialogues, in small or large groups, language is put to use in all of its various forms:

- through activity, during specific discussion can occur about the objects or facts on which the observations or inquiries focus: the aim will be to name, describe, compare, qualify, quantify, categorise and arrange, in the proper order, what is present in the here and now.

It is also the opportunity to exchange viewpoints and thoughts and begin to reason as a group; language is then used to ask, question, comment, establish relationships (causality, time, space), state and substantiate one's viewpoint, state and substantiate disagreement with a classmate;

- at the beginning or end of a session, when the time comes to review what has been done, seen and understood, appraise the situation or plan additional sessions, language makes it possible to anticipate, predict, reframe, and state in a more general manner.

Verbal Language

Research and exploration situations in the field of science offer breadth and complexity that stimulate interactions of all kinds, underpinning the actions and reflection process of all involved.

Activities bring continuous vocabulary enrichment as they take place and, to this end, the teacher should feel free to suggest words that make it possible describe reality precisely.

From the first year, where the differences between the children are large and their language abilities still limited, to the third year, where language has become much more elaborate, the time devoted to longer group exchange can gradually increase.

To Exchange with Adults and Speak for Oneself

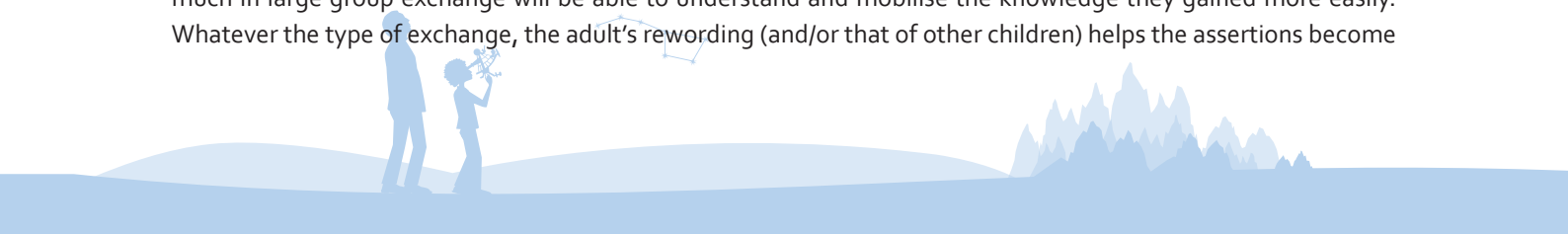
During special, short and varied, teacher/student dialogues, the child can base his speech on that of the adult, assert his beliefs and consolidate the language forms being acquired. Such times can occur upon arrival (going to see who is involved in experiments, comment on a record from a previous activity, restate what is being researched, etc.) or are suggested when the student's attention drifts from the group activity.

Younger students often need, for themselves, to repeat, during a fleeting lone moment, a gesture or action previously experienced. Such times, which allow them to take ownership of the recently-acquired knowledge, need to be arranged periodically, and are also a time of monologue (doing again and again, saying again and again). The monologue is more or less internal, and later enables the student to better understand and participate more actively, particularly in large groups.

Exchange

Organised exchange based on concrete and varied supporting materials, depending on the objectives, leads the children to express their own personal ideas, and thereby clarify their observations or thoughts to make them comprehensible, become aware of differing viewpoints and gradually take into account the opinions and thoughts of others. The teacher, in the third year of pre-school, shall begin by having the children reason about different viewpoints and ways of expressing them; he will help them realise that certain forms are better than others because they are more accurate and more precise.

While group settings are not the most efficient place for individually developing language skills, it is important to bring all the students together to mobilise them and better define the activity underway, as well as elaborate upon and hone the group assertions that will later serve as reference points. Language skills are developed in part during shared reflection, and in part in small groups. In the latter format, the students who do not participate much in large group exchange will be able to understand and mobilise the knowledge they gained more easily. Whatever the type of exchange, the adult's rewording (and/or that of other children) helps the assertions become



more precise and appropriate, and fosters the emergence of increasingly well-organised knowledge statements. The teacher's word is precise and stable enough to establish reference points that the children will be able to grasp. It does not impress upon the children any language forms that are overly formal and in which the latter would not recognise the nature of their own action on the real world or their personal relationship with the object.

Verbal Language and Producing Records

To help children speak up and underpin the concurrent enrichment of language and thought, a variety of materials can be implemented: albums, photos, drawings, pictures, prints, models, audio or video recordings and various types of writing. When based on concrete materials, the child's comments can become more confident, accurate, organised and structured. Keeping a record, then, contributes to capitalising on what is learned. All of the "written records" that can be gathered or built up in the classroom help both give meaning to writing in all forms and build up new knowledge.

A Wide Variety of Records

Whether produced in class or gathered, written records can vary in nature: they can be individual and/or joint, figurative and/or symbolic, flat and/or volume-reflecting, brought in, taken from albums, books and any number of documents, or objective (photos, prints, etc.).

Records have different functions:

- they are mobilised throughout the thinking, elaboration, relationship-identification or organisation stages to clarify questions asked, guide actions, inform debit and stabilise information learned;
- their status helps better distinguish, on identical themes, the reality that is to be represented (picture of a plant every Monday, pictogram collages or codes on a calendar, drawings with comments, etc.) and the imaginary world (tales, rhymes, plastic creations, role-playing games, etc.).

Children invest a great deal of themselves in what they produce; by using drawings to show what has changed or what "is the same", the teacher can gradually help the children distinguish between imagination-based or expressive drawings from those intended to inform or flowchart drawings.

The percentage of objects produced by the child (copy, writing, drawing, flowchart, etc.) varies according to the skills he has acquired. Dictation to the teacher, which makes it necessary to change spontaneous oral expression to express a text in written language, is a particularly well-suited form of work to keep a record of a stage in the activity or provide a final assessment thereof.

Moving from the verbal to the written makes it possible to frame the lessons learned in time and establish reference points therein. Inversely, once it becomes a habit to use the written record from a previous session for the present one, this helps make full use of the records, intended to serve as a memory of schoolwork and support what the students are supposed to have learned.

Organising Production

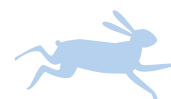
The students' language productions (oral and written) depend in large part on the type of activity, actions and interactions involved. In pre-school, they remain highly dependent on the supporting materials chosen by the teacher. It is important, especially with regard to written production, to keep from falling into stereotypes, even if regularity or similarity is necessary. The written word needs, first and foremost, to reflect the intentions of their author.

Group Records

Produced at review time or during the reflection periods provided during the activities, using appropriate materials (posters, panels, etc.), they help gain perspective, foster the reorganisation of existing conceptions, and the emergence of new categorisations.

In various forms (use of previous individual records, new depictions or portrayals), they form group memory, one that is available and capable of developing. They can come in the form of a group class album. Elaborated with all of the student and group albums:

- form a classroom record that can be passed on and put to use on a regular basis;
- bear witness to classroom activity;



- help select the presentation and depiction methods that may be taken on board again later;
- provides the children with a level of expression that is more developed than natural speech;
- establishes a system of reference points arranged over time.

It may include a variety of records (pictures and drawings with comments, student opinions about what they learned, etc.) and an introductory text by the teacher (objective, method, student organisation activity, for instance).

The group album shall be available to the parents for viewing inside the classroom. Lastly, the teacher may find it beneficial to create ties with other group creations, such as a picture album or class dictionaries.

The Individual Album, a First Experiment Notebook

This enables the children to better identify the place of what they learn in the activities carried out in school and gives them concrete reference points to use the shared classroom tools.

It contains all of the records produced or chosen by the child, alone or with the help of his peers or an adult. If so desired, the album may contain pages dedicated to exploration done at home, about the topics covered in class.

It needs to be available for viewing by the child during subsequent activities and is a foundation for dialogue between the school and family.

Major Development Areas and Changing Role of Teacher from First Year to Third Year

In vocabulary and syntax

- Provides vocabulary components needed to name and qualify.
- Sparks comparison and relationship-identification.
- Reviews the relationships identified to foster categorisation increasingly in line with knowledge developed.

In producing records

- He works from the questions asked, in order to move toward creation.
- The teacher helps review previous creations, to complement or re-state them.
- He supports the production of records and a variety of written accounts, and ensures that the creation does reflect the child's intentions.

Cognitive Sciences – Shedding New Light on Certain Instructional Issues

A new branch of psychology has emerged in recent years: cognitive sciences. They focus on brain functions and their material substrate, the brain, as an external scientific object, without focusing on personal introspection or analysing the subject's history.

The cognitive sciences do not deny the importance of human subjectivity, differences between individuals or personal history, but rather aim to identify the characteristics common to the functioning of any human brain. The main postulate of cognitive sciences is that brain function, from simple functions such as reacting to a line placed in the field of vision, to complex cognitive functions such as language or awareness, can be broken down into processing stages, performed by groups of neurons whose function can be defined. For example, language can be defined as in Le Petit Larousse dictionary, as "a faculty specific to man to express his thoughts using a structured system of signs", but over-generalising on this definition makes it difficult to understand how the brain perceives and produces language. The approach taken in the cognitive sciences will thus be to break down that faculty into a series of steps that can be analysed separately.

For example, looking only at how speech is perceived, an acoustic wave needs to be transformed into electrical impulses, that the information subsequently be converted into phonemes and syllables which will themselves be combined into words. A meaning and grammatical function will be assigned to the words. All of this will be put into perspective to achieve an understanding of the sentence that is not only literal, but possibly including implications and sub-meanings. Together, the steps take no longer than a few hundredths of a millisecond, and successively or concurrently calls upon many different regions in the brain, in particular the left brain, where language is



concerned. As long as no difficulties arise, we do not realise the complexity of the operations constantly occurring in the brain; however, a stroke that suddenly cuts off access to one of the operations or, more simply, a conversation in a foreign language in a noisy bar force us to realise that the machine can “freeze up”. Likewise, cognitive development in children may sometimes not occur as harmoniously as planned and a specific loss, like dyslexia, dyscalculia, etc. can complicate their schooling.

Even in children without any specific disorders, learning can be made easier or, to the contrary, hindered by the cultural environment or instructional practices that interfere with the constraints due to our brain’s special functioning procedures. For instance, due to the inconsistency of graphic-phonemic conversion, English-speaking children learn to read more slowly than their Italian or Swedish counterparts. Even more striking is the fact that Italian adult readers read at a higher speed than English adult readers. Turning to another example, the number ten is clearly indicated as the base for numeration in the names of numbers in Chinese, whereas in Western languages, the inconsistency between names between ten and twenty makes it harder to integrate this concept, not to mention the French language, with the names of certain tens. In both cases, it is clear that cultural practice may or may not foster learning.

The complexity of the brain is impossible to broach in its entirety. In contrast, it is possible for us to understand where and how a basic operation can fail. The brain is not a computer. It is subject to specific laws, which result from its biological and evolutionary heritage. The value of the cognitive sciences is that they make it possible to better understand how our brain processes the information entering it and how it can reorganise that information to gain new knowledge. In a society that is increasingly complex from the technical standpoint, it is urgent that the entire population master certain types of knowledge. To meet this requirement and help ensure that certain key stages are successfully completed, such as learning how to read, proficiency with numbers, logical analysis, etc., we need to understand the constraints, resulting from brain functioning, that influence the said learning processes.

Without purporting to reduce brain functioning to a purely mechanical and electrical model, cognitive sciences are moving in that direction. As we have illustrated through a number of examples, they are capable of shedding new light on a number of very longstanding educational debates. It is in that sense that we feel it is interesting and important to call pre-school teachers’ attention to the emergence of this field of knowledge.

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and Denis Le Bihan (Academy of Sciences).

To learn more

Brigaudiot M., Falaize B., Temps et temporalité, CNDP/CRDP du Limousin, 2002, coll. « Doubles pages ».

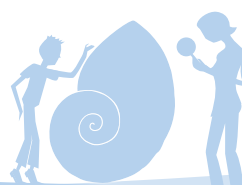
Sequence Outline

This sequence outline is based on the supporting document outline provided with the “Teaching the Sciences in School” programmes and takes into account the features specific to pre-school in the field of living organisms, objects and matter.

It should not be taken as a model that might lead to an over-stereotyped operating system. The stages described are actually found in the various sessions carried out, but are not a universal description applicable to every sequence.

The sequences described hereafter clearly show how flexible the plan is and the wide variety of options it holds: it contains the approach, but implemented in very different ways.

The knowledge gained is structured throughout the students’ inquiry process, guided by their teacher, with high points upon completion of each science and technology session, generally when the groups come together again. This is an opportunity to work on the children’s language, which is gradually developing: acquiring appropriate scientific vocabulary, expressing causality and establishing relationships between various factors.



Choosing a Starting Point

- Choices to be made in accordance with curriculum objectives and in line with school mission and grade.
- Productive character of starting point: often fun, rooted in action, so as to stir curiosity, exploratory behaviour and the enjoyment of learning.
- Local resources (materials and documents).
- Relevance of study undertaken with respect to interests of students and awareness-raising, sustained by classroom activities and projects.
- Consideration for the progressiveness inherent in learning, throughout the pre-school years.

Aiming to Question as a Class

- Time is required to first become familiar with the concepts, through exploratory activities designed by the teacher.
- Process guided by the teacher, who helps bring out questions and how to express them verbally.
- Choice guided and substantiated by the teacher as to how the meaningful questions will be used.
- Emergence of and consideration for students' initial conceptions (regardless of how they are expressed, or the influence of the imagination or affectivity). Comparison of any divergences to encourage the class to take ownership of the problem raised.
- Identification of approach to be implemented (relationship with reality, aiming toward rationality). Important stage in structuring language, one possibly requiring time in various formats (alone, small group, large group).

Student-Conducted Activity and Inquiry

- Importance of exchange in large groups at this stage of the approach.
- Teacher manages student arrangement (alternating large groups and small groups), instructions given (functions and behaviours expected within group).
- Student-devised assertions, suggestions and projections encouraged and recognised by the teacher.
- Evocation of action to be implemented in words or through gestures (or, for older students, series of actions).
- Students express their projections verbally: "What do I think will happen?" (and for older students: "what are the reasons for this?").
- Rewording of teacher's instructions.
- Various forms of inquiry structure (entire class or small groups).
- Differentiation between procedures for student exploration (possible participation in workshops, expectation levels different and suited to pace of each student, variation in degree to which teacher guides work).
- Adult encourages exchanges between children.
- Importance of producing various records:
 - varies according to children's age;
 - either produced by the children: drawings (where adult writes comments, notes the date and name of workshop) and/or verbal description;
 - or produced by the teacher: summary, chart, photos, films, audio recordings etc., produced to summarise and remember activity in progress, possibly included in the experiment notebook.

Structuring Knowledge Gained

- Comparing and establishing relationships between results obtained during investigation, generally during group time, the preferred setting for constructive exchange.
- Comparison with established fact (use albums, documentaries, audiovisual materials, etc.) using wording levels that the students can understand.
- Looking for causes of any disagreement, critical analysis of experiments carried out and additional investigations suggested (often suggested by teacher).



- Written depiction elaborated by students or teacher (depending on age) as a group (class album, posters, pictures with captions, films, etc.) and/or individually (journal, experiment notebook, etc.). Use of those creations to communicate in the classroom, school and with the outside world.
- Activities to re-integrate the varied settings over the course of the cycle, rounding out and further structuring newly-gained knowledge.



Food - Where does bread come from ?

Author : Françoise Hurtrelle, Ecole du Canteloup, Honfleur- Calvados, France

Summary : Some ears of wheat brought to school by one of the children led to the experimental discovery by pupils of all the steps needed to make bread, from the germinating of the wheat grains up to the final baking of the dough.

Programme content : living things – learning to be healthy - Importance of rules of hygiene (food)...

Issues approached : food-digestion, plants.

Award-winning project : prix *La main à la pâte* 2000

Initiating scenario :

A spray of wheat ears brought to the class by Ridwan.

Breakfast at school with serving of cereals.

Use of and interest in a book entitled " Little Red Hen " by Byron BARTON (" La petite poule rousse " L'Ecole des Loisirs): the pupils' wish to reproduce the story's action in chronological order.

Objectives :

Discovery of a plant: wheat.

Matter : flour in human and animal food.

Survey : in which food is flour visible ? Recipes and discovery of other cereals.

In technology

Turning wheat into flour – Study of the different methods : grinding and sifting.

Discovery and use of different tools: flail, different mills, sieves (etc.) ; introducing the notion of adaptation to functional use.

Transforming through mechanical action.

In grammar

Type of situation with sequenced projects imparting the notion of time:

- what has been done,
- what remains to be done,
- what could have been done,
- what could be done.

Pupils naturally acquire skills in the use of verb mood and tenses .

Action chronology : one action per week.

In history

Introduction to the notion of History: methods used in the past, present day methods.

It was before ...

In past times by hand, scattering seeds, with a flail, a combine harvester, a scythe, using a mill ...

Now we use ...

Flashback : before we did this, afterwards we will ...

Describing and discovering features of the past by comparing action, tools and objects before and now; hence the idea of visiting a farm.

In biology

Introducing the notion of life: "What do we mean by a living being ?", "What is alive ?"

Observation of plants, in the classroom, in the garden, on a nature walk (bois du Breuil).

The lifecycle : nutrition, growth.

Teacher's comment:

This work was conducted by children "with learning difficulties".



Sequence 1 - From wheat to flour

Pupils prepared and then tested operating methods, compared different techniques, to obtain grains from wheat ears, to separate the grain from the chaff, to transform the grains into flour.

a- Discovering wheat : sowing seeds

Where does wheat come from ?

Initial scenario

After the Summer holidays, Ridwan brought a few wheat ears to school, but was unable to tell us what they were or where they came from.

None of the children could help since wheat was apparently unknown to them.

At a later stage, they did all recognize straw.

Observation and questioning

Wheat ears : Can they be eaten ?, Have you already eaten them ?

"They're grains. They're Kellogg's cereals !"

One child bites into a grain: "it's hard, it's white inside."

Only Johnny thinks that the white part may perhaps be flour.

Final questioning

Where does it come from ?

Where does it grow?

Seeds

Objectives

To make children aware of plant life and move on to a deeper understanding of the basic notions of time, space and relationships, the concept of life (germination and growth).

What is living ? Are flowers, trees alive ? And things, like stones ?

Notions of history : in the past sowing was made by hand, nowadays a sowing machine is used.

Activities

Sowing of seeds just before the November holiday in the classroom and in the playground



One pot placed in the light in the classroom, the other in the dark (in a cupboard).

On 13 November: shoots a few centimetres high.

«They grow quicker in the classroom !»

General reaction : « It makes grass ! »

We had also sown some pumpkin seeds.

Axel makes a comparison between the wheat seeds and the pumpkin seeds: «Then these will give us orange grass ?»



«They'll give leaves.»

Problem encountered : In the classroom, the plant grew quickly but also withered quickly.

Documentation

« Toujours rien » Edition du Rouergue

« Quel radis dis donc ! » Didier Jeunesse Ecole des Loisirs

« Rosie plante un radis » Casterman

b- From ear to grain : wheat threshing

Objectives

Introduction to the historical aspect. Before " It was in the past "

In the past, a flail was used. Nowadays a combine harvester.

1 – Wheat threshing as per pupil suggestions.

Problem scenario

How can we separate the wheat grains ?

How can the wheat be threshed ? (The wheat is spread on the ground)

Charlotte : "You have to walk or jump on it ." (The children do not know the verb to trample.)

First test :



Observation : «Oh ! surprise. There are grains. We were right. The wheat grains have fallen on the ground .»



Johnny : «We could beat with a stick.»

« What happens if you beat straw ? » ... «Nothing»

The difficulty lies in beating the ears hard.

Johnny uses the stick like a pestle.

Other suggestions : «We could beat like this (holding flat), like with a flail.»

Shake the ears (the verb to shake is unknown to the children). They show the movement.



Beat with our hands



Rub with our hands



Shell the ears («Peel» says Charles)



The class picks up the wheat grains mixed with the chaff.

Observation : it's quicker using your feet. The wheat grains fall with the small flakes (the chaff).

Lucie shakes the bowl containing the wheat to remove the chaff.

Remarks : It is found that some ears are well beaten, others rather less well, and others not at all.

Nowadays it is a combine harvester which threshes the wheat. It threshes all the ears.

2 – Threshing the wheat with a flail

Motivation

“ We are going to beat the wheat with the flail, as they did before, like they did in the past .”

The activity is conducted in the playground to have more room.

Presentation of the tools used: a fork and a flail.

Observation - Analysis

Description of **the fork**. The word is known by Axel.

Jason : “It looks like a hand, like fingers .”

Charly : “It’s made of wood.”

Use : “ What is a fork used for ? “

Margaux : “To separate the grains and the straw.”

Charly : “It’s for pushing. It’s for picking up the straw .”



Description of **the flail**. The children remembered the name and its use from the documents they had brought to school .

Charly : "It's got a big wooden stick and a little stick."

Johnny : "It's got a handle."

Benjamin : "There are two pieces of wood."

Davy : "Thick string."

Axel : "A rope."

Why has it got one long stick ?

Charlotte : "Cos it's a handle."

Which stick is used to thresh the wheat ? "The big one !"

Introduction of a new word " a bat".

Use

Why is wheat threshed ?

Jason : "To get wheat, to get grains."

Technical functioning: How does it work ?

Experimental test : "You have to beat with the end bit." "First we must lift the bat." "You must beat the ears."



Problem: it's difficult as it is not a tool intended for children.

«It's for grown-ups.» «You must beat hard.» «You must lift it up high.»

We nonetheless obtained grains and saw many grains falling from the ears.



Separating the grain from the chaff

Initial scenario

What must we do to separate the grains from the chaff ?



Tests

Lucie shook the bowl containing the wheat grains and the chaff .

"What happens to the grains ? " "What happens to the chaff ? "

"It flies away . But the grains also fall."

"You have to use your hands to sort them . It's long and there are lots."

"We could tap the bowl. We could shake gently."

How ?

"From top to bottom. From left to right. Backwards and forwards."

"The grains move together, the chaff moves to the other side. But it takes too long."

Using sieves



«The grains don't go through the holes.»

«If we shake hard, everything spills, everything jumps overboard.»

In the past, a big basket was used: A WINNOWER BASKET.

Machines too were used



And nowadays ?

Sample of wheat from a farm, harvested with a combine harvester. "Now, the combine harvester does everything."

Charles

c- From grain to flour

Initial scenario

How can the wheat be crushed to obtain flour ?

Johnny : "With your teeth. It works but it's hard"

Margaux : "With your hands."

Sarah : "With a stone."

Dylan : "With your foot. It doesn't work, the grain is too small, it sticks inside the soles."

Sarah : With a hammer."

The others : "With a big stone, with a brick."

Axel : "With the vegetable mill when we've made the pumpkin soup."



Material to be prepared

Objects for grinding, crushing, spreading .. : vegetable mill, old-style coffer grinder and an electric coffee grinder, pestle, mortar, rolling pin, pebbles...

After suggesting initial solutions, and with the instruments supplied by the teacher, the children are divided into different workshops. (The children are given various items meeting this functional use : vegetable mill, manual coffee grinder, electric coffee grinder, pestle, mortar....).

Workshop sessions

Workshops:

pebble workshop

electric coffee grinder workshop (with adult assistance for safety)

vegetable mill workshop

manual coffee grinder workshop

rolling pin, pestle and mortar workshop

On completion of the first tests, the class pools its findings: what happens when each of these tools are used ? Is it easy ? Why ? Is it difficult ?

With the rolling pin: "it doesn't work, the wheat is too hard."

With the pestle and mortar: "It's too hard."

With the vegetable mill: "It doesn't work. It doesn't crush anything."

With the pebbles : "It works but it takes too long." Some pupils crush the grains without beating. Others rub the pebbles together. Many children prefer to bang the pebbles together, a pretext for making a noise, but notice that those who crush the grains with the pebbles succeed better in obtaining flour.



With the hammer: «It works.»

With the manual coffee grinder, the children turn the handle in the right direction , it is very difficult. Some strength is needed but they manage to crush the grains. To see the flour falling into the drawer gives them great pleasure and they are most satisfied.

With the electric coffee grinder : "It's easy. It's quick. It's properly crushed. The flour is soft."



Comparison of the grindings obtained in each workshop.

The children notice the difference between the flours.

Each tool used has crushed and ground differently.

Pooling of results: white flour, whole flour, bran.

d- Sifting

Introduction

Recall

Recall of the different ways of crushing and grinding.

Comparison of the grindings obtained

Comparison between the different grindings obtained during the previous session.

"Some are white. Some are yellow."

"The white ones are flour. The yellow ones are bran. It's the wheat's skin."

The class obtained :

coarse grains from the wheat crushed with the pebbles,

fairly fine grains from the wheat ground with the old coffee grinder,

very fine grains from the wheat ground with the electric coffee grinder.

"Why are the grains finer with the electric coffee grinder?"

Comparison of the grindings with flour bought from a shop

What must we do to have white flour ?

"Take away the yellow. Take away the bran."

How can we take it away ? How can it be separated from the white ?

"With your hands" "It would take too long."

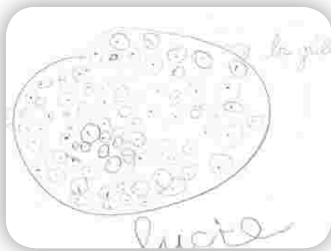
The teacher: "We are going to sift the flour using an instrument".

Charlotte remembers the instrument with holes but cannot remember the name. You have to shake it like we did with the wheat.

Sieves, strainers, colanders brought in by pupils

Workshop session

Pupils are divided into three workshops with the various instruments



Comparison between the different flours obtained :

But some bran still remains, especially in the «colander» workshop.

The whitest flour is found in the «sieve» workshop.

Which is the softest flour ?

On feeling, all the children designated the sifted flour.

Why is some flour finer ?

«Some have big holes. Some have small holes.»

Benjamin : "The bran can come through the big holes."



Comparison and observation of the holes of the sieves.

The mesh of the two sieves is different. One is even finer.

With this sieve the bran has been left behind. Why ?

"The flour can pass through, but not the bran."

The flours obtained are weighed.

Dylan : What does to weigh mean ?

Margaux : We can weigh ourselves like this, standing up.

With 1 kg of flour, much is lost through handling.

Attempted summary

The bran does not pass through the mesh.

Which sieve must be chosen to obtain white flour if it contains bran ?

The finest sieve must be used.

Sifting mill

Objective

Having understood the principle of sifting, will the children be able to find out for themselves the use of a sifting mill ?

Initial scenario

The class is presented with a sifting mill.

What was this object used for ?

The class scrutinizes, observes, thinks.

"There's a handle. It turns." "It's for grinding wheat. It's for crushing it." "There's a sieve. It's for sifting."

Tests

The children try to make it work. They remove its different parts. Try to make an analysis.



«It turns. It doesn't crush the wheat .» " It's the handle which makes the wooden bit turn ." "It can be turned quickly." "It's the blade which shakes the flour."

They make a deduction



«It's like the sieve. The flour falls. The bran stays inside, it's too big.»

They try it out. Comparisons are made. And it is concluded:

«It must be for sifting.» "Instead of shaking, it is turned, there's a blade, it turns, then it's a mill."

Lots of bran is left in the sieve.

It is a fine sieve.

So the bran cannot pass through.

The flour in the bottom is almost white. It is soft.

Charles: "For the flour to be white you have to sieve 'til there's no more bran."

Ridwan : "You have to sieve all day."

e- Assessment

Understanding sequence of action

What tool has to be used to grind, to sift ...

Explanation and overview of results obtained.

Argumentation

"The grain is too coarsely crushed, why ?"

"The flour has lots of bran, why ?"

"Which tool should be chosen to obtain almost white flour ? Why ?"

Workshop sessions

In small groups of four, specific workshops are organized to transform the wheat grains into flour .

The wheat has to be beaten or shelled.

Separate the grains from the chaff.

Grind the wheat.

Sift the flour.

1 – The grains are removed

2 – Sorting is made by hand

The sieve is used to separate the chaff from the grains. If you blow, the chaff flies away,

The grains go here, the chaff goes there.

You shake from left to right like this and up and down. The grains do not fly away.

3 – Crushing with the pestle, with the hammer, with the mill

With which tool is it easiest?

4 – Sifting, that is to say to separating the bran from the flour.

The different actions were conducted in proper sequence.

The only confusion made concerned the use of the sifting mill.

f- Visit to a watermill: le moulin d'Ablon

Mr and Mrs. Sénécal, the owners of the watermill, set the mill back in operation for us. (drawing)

Analysis of the mechanism

Drawing a parallel with the simple actions conducted by the children:

crushing the wheat in different ways (the children),

crushing the wheat between millstones by a watermill.

Children's reactions to the watermill

We had better not put our fingers in the big millstone. Charlotte.



It's impossible; it has wood all around. Sarah.

The one underneath isn't turning. Johnny.

Watermills only existed in the past. Yohann.

It isn't the wheel which pushes the water, it's the water which pushes the wheel. Axel.



It's the miller who turns the "things" (gates) to make the water stronger. For the wheel to turn quicker. Jason.

They're mechanisms. Ridwan.

The wheel behind the wall is very big, it makes the mechanisms turn.

There's a middle-sized wheel and a small one too. Charles.

The wheel makes the mechanisms turn, the mechanisms make the millstone turn. Margaux.

The bag of wheat is hung by a chain. Charlotte.

The planks up above (trap door) are opened. Benjamin.

The bag goes up, then the wheat falls into a big box (hopper), the wheat falls, some is shaken. Alexis.

The wheat grains fall between the millstones.

They crush.

And the flour falls down into a pipe. It's whole flour. Dylan.

After the visit to the mill, the children asked the following questions :

What crushes in the mill ?

What is it which crushes ?

Yohann : The mechanisms, the handle makes the mechanisms turn. Look inside, the drawer has to be taken out.

Davy : I know why it crushes ... 'cos there's teeth.



Sequence 2 - From flour to bread

In class, pupils made their own bread. After this work, they visited a bakery to discover how bread is made in large quantities.

Programme content : living things – learning to be healthy - Importance of rules of hygiene (food...)

Issues approached: food-digestion, plants.

a- Breadmaking in class

The following are mixed together:

flour : 500 g

warm water: 30 cl

yeast: 10 g

salt: 10 g

The dough is kneaded and left to stand for 20 minutes :



The dough is shaped into a loaf,



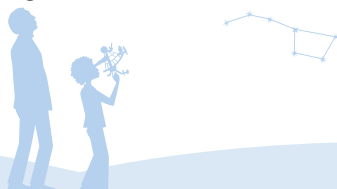
cuts are made in the top surface,

the dough is left to rise for 3 hours and 30 minutes.

The bread is baked for 45 minutes,



and is ready for eating !



Scientific approach

Analysis - comparison

The dough has risen.

Why ?

Formulating a hypothesis

It's the yeast which makes the dough puff up.

Experiment

Make bread WITH yeast.

Make bread WITHOUT yeast.

Conclusion

Yeast makes the bread rise.

Other experiments to compare taste, texture, colour

1: Making bread with whole flour.

Making bread with sifted flour.

2: Making bread with salt

Making salt-free bread

Observation of changes in consistency, colour, taste before and after baking : heat and time.

Observation of time left to rise and baking time compared with recreation time, breakfast time, or lunch at the canteen.

b- Visit to the bakery

Objectives

To discover the baker's shop and bakery.

Discovering the bakery

Discovering how bread is made



Who works in the bakery ?

What is the baker doing ?

What is the apprentice doing ?

Which machines are used to make bread ?

Kneading machine, oven, cutting machine.



Presenting the baker's shop



Who works in the baker's shop ?

What is the baker's wife doing ?

What is the shop assistant doing ?

The children visited a bakery after completing the "from flour to bread" activities. They were well familiar with the recipe for bread, the order of sequences for its preparation, and with the tools and machines used..

This visit gave them the opportunity to test their knowledge and appreciate the quality of a professional person's know-how.

We asked for advice on kneading and baking



Sequence 3 - Project Appraisal & Open Day

On an Open Day, pupils were delighted to show their families all their knowledge on the subject, inviting the adults in their turn to “put their finger in the pie”.

Programme content: living things – learning to be healthy – Importance of rules of hygiene (food...)

Issues approached: food-digestion, plants.

a- Project appraisal

Acquisition of know-how.

In action:

To remove the chaff from the grain

“It’s easier to blow on it. It works quicker than by sorting.”

To crush the wheat with the pebbles: adapting action to achieve a crushing function.

“You don’t hit, you rub, you crush with the small pebble.”

“You don’t hit, you rub, you squash with the small pebble.” (the top one)

In choice of instrument. Adapting to functional use.

Choice of the electric coffee grinder to obtain well crushed wheat.

Choice of the finest sieve to obtain whiter flour.

Acquisition of understanding and knowledge

Development of a critical mind.

Seeds: becoming aware that a seed gives birth to a plant, that the plant is born, lives and dies, hence the need to water it and place it in the light.

The wheat planted in dry ground did not germinate.

The wheat in the pot closed inside a cupboard germinated and grew. But the shoots were yellow instead of being green and they withered quickly. «Mustn’t put it in the dark “ Dylan

Mills

Johnny : “the millstones are like us with our pebbles, they crush.”

Ridwan : “the one underneath doesn’t move. The one on top turns”

Yohan : “it was in the past that people did like this.” (during the visit to the mill)

Interest in documents: more consulting, searching;

Children compare action, tools used in former times with those used in class, those used at the present time. Charly shows a picture of work in the fields: “It’s better with the combine harvester. Before it was very long. Before the men must have been very tired. “

Greater technological inquisitiveness and more questioning.

Before going to visit the mill and before starting work on the working mechanisms, the children had never wondered:

how a coffee grinder works.

how it crushed.

for them a coffee grinder crushed, and that’s all, its actual working had not seemed of interest to them.



b- Possible extensions

Learning gear mechanisms based on the mill



Learning the use of scales by weighing wheat, flour, bread

Construction and experimenting with different types of scales.



Using magnifying glasses to observe the wheat, flour, bran and representative drawing.

Making a grain and seed cake to feed the birds in Winter.

Making fat liquid by heating and solid by cooling.

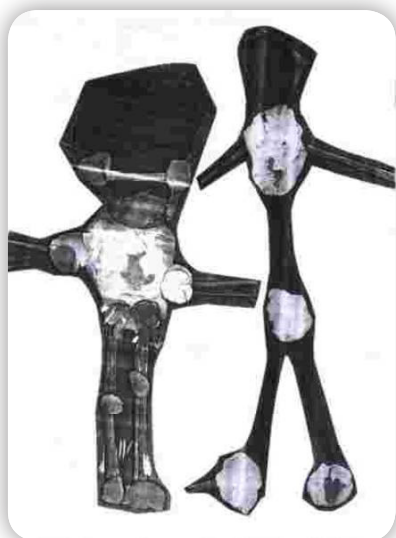
Wheat as animal food and especially for the chicken we have in the playground.

Use of straw and bran.



Culinary activities: cakes, pancakes...

Art activities : various creations using straw, grains.



c- Open Day

Objectives

To prompt parents to take part in the project.

To show them their children's know-how.

Starting from an ear of wheat, children follow all the process stages needed to make flour. (Chronological anticipation)

To make bread from:

- whole flour (the flour produced at the water mill).
- sifted flour.

Organisation

According to their choice, the children are divided into different workshops.

- 1 - Workshop : from wheat to flour.
- 2 - Workshop: from flour to bread.

Material

Pebbles, various mills, various sieves, colanders, salad bowls, spoons, plates, cups.

Procedure:

Workshop one – from wheat to flour

Each child is given some wheat ears and changes section at his/her own rhythm and according to need.

Several activities have to be completed in proper sequence:

- 1 : Shell the wheat ear
- 2 : Separate the grain from the chaff: by blowing on it.
- 3 : Crush the wheat to obtain flour : using pebbles, manual or electric coffee grinders.
- 4 : Sift the flour obtained using the sieves, colanders, sifting mill.

As and when the children have produced their flour, they supply a modelling workshop for their parents with modelling dough made from flour, salt and water.

Workshop two: from flour to bread

Making whole bread using the flour produced by the water mill in Ablon. Making white bread.



Review of the Open Day

Difficulties : material installation must be well prepared so that all the children are busy at the same time with specific material.

Positive outcome:

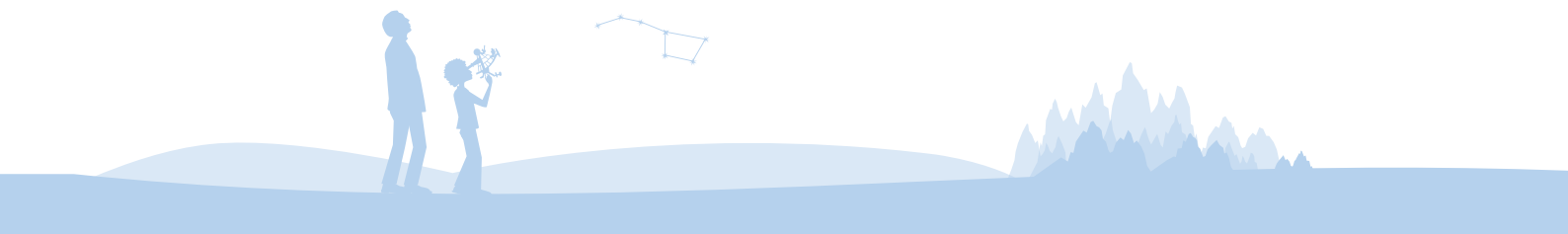
The children fully completed their activities.

The children were pleased to see their parents' interest in their activities.

The parents "put a finger in the pie".

The parents appreciated the Open Day and its activities.

The sequence lasted more than one hour, all the children were most active in a very calm atmosphere



Our body in movement

(Ages 8 to 11)

Authors: Jacques Soustrade, IMF / Colette Gouanelle, professeur IUFM - Ecole Paul Lapie, Bordeaux-Antenne de Gironde IUFM d'Aquitaine - France

Summary : This is a module made up with six sequences to discover the human skeleton and understand how muscles are linked to bones and allow us to move our body.

Program content: Human body and education to health, body movements in sports and work.

Issues approached: locomotion, movements

Scientific field : biology

Remarks : This progression is based on a cycle of dance to which the pupils participate and which serves as a starting point. The teacher tries to initiate 8 to 11 years old students to the learning process of "solving a problem": alternation of phases of formulation, questioning, investigation and structure. As for writing, whether individually with a diary for example, or reformulated with the teacher during the sequences, it plays an important part to communicate ideas, recenter the debate and structure a knowledge.

Sequence 1: What makes us able to move?

(initial scenario and start of problematization)

Objectives :

- of method:
 - To learn to express feelings through drawings.
 - To clarify thought, structure ideas and express them in schematic form so as to be able to communicate them to others.
- of attitude
 - To put one's imagination to use
 - To know how to face criticism

Progress of the sequence :

Subsequent to a dance sequence, the teacher asks the pupils to depict themselves dancing.



- Pooling:

The drawings are compared and it is sought to identify those which best express movement. Pupils' answers are written on the board. It is concluded, after verifying with a few pupils who repeat the movements in front of





the class, that it is when the limbs are bent that movement is best perceived.

- Presentation of own experiment books:

"This experiment book is for you to take notes: everything you think about movement, everything you discover may be noted in this book. You can make drawings. You may take this book home."

- Diagnosis of individual knowledge:

The teacher then asks the children to explain in writing what it is which enables our body to make movements, and suggests that they draw what is happening to their arm as they write. The teacher collects the pupils' work and takes the time to analyse their efforts.

Duration :

Approximately 45 minutes

Material / Preparation :

Per pupil : 1 sheet of paper, felt pens, 1 exercise book

Starting situation :

This progression is based on a cycle of dance to which the pupils participate and which serves as a starting point.

Sequence 2: First statements of fact

(initial concepts giving rise to the problem of bones and their joints)

Objectives :

- **Objectives of notion**

To distinguish the parts of the body which move (limbs or parts of limbs, eyes, mouth, ...) organs which make movement possible (joints, muscles, brain).

- **Objectives of method**

To know how to focus on a scientific issue.

To classify ideas, categorize, reformulate questions.

To formulate hypotheses.

To argue.

- **Objectives of attitude**

To learn to place one's ideas in doubt, and the ideas of others.

To show inquisitiveness.

Progress of the sequence

- Pooling:

After a quick review of the work done in the previous sequence, the teacher lists the body parts cited by pupils in their written work and asks them to classify these answers. This joint classification will lead to pupils to making a distinction between:

- Parts of the body which can move (limbs or parts of limbs, eyes, mouth...)

- The places where movement occurs which they know under the term of a joint without exactly understanding its meaning; the pupils agree that some parts of the body can be bent, or can turn at the site of the joints (notions introduced during the age 5 to 7 key stage).

- What causes movement (perhaps the bones, or the muscles or the brain)

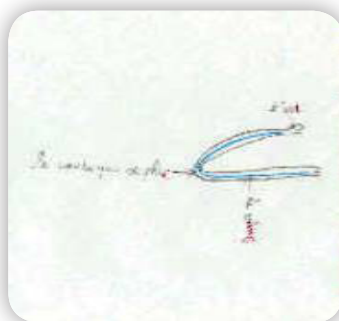
- Work in groups



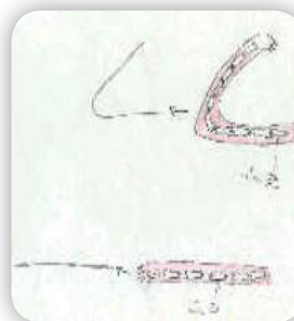
The teacher distributes the five drawings (numbered A to E) chosen from among those pictures drawn individually and asks pupils to compare them and to say whether they agree or do not agree, explaining why. the replies must be entered into a group chart.



A



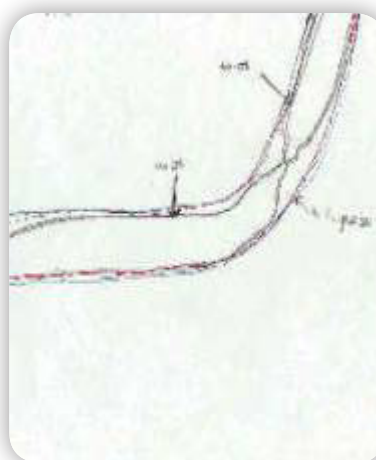
B



C



D



E

Examples of answers given by one group :

B : there are more bones than in A,C,D,E

C : it is not possible for a bone to be completely bent and the vein is not in the bone

D : the key makes it clear

A : the bones are attached

E : the bone of the forearm is not twisted

Duration:

Approximately 45 minutes

Material / Preparation :

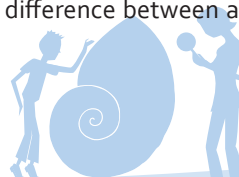
Per group of 4: 1 copy of 5 chosen drawings (previous sequence)

Remarks :

Before this second sequence, the teacher makes a wall chart listing the body parts or limbs cited by the pupils in their replies to the question "what makes us able to move?". The teacher will also have chosen five drawings made by pupils (showing the inner arm) which are the most representative of the initial concepts.

A word by the author:

The five drawings used in the work groups and enlarged, and the written work just completed, are posted on the board. Pupils read each group chart in turn and the ideas expressed are discussed as are the formulations used. The teacher uses the opportunity to lead pupils to making the difference between a finding (we have only





described what we have seen) and an opinion (we agree or do not agree). The teacher prompts pupils to argue their opinion. In this manner some sentences come to be reformulated and they are re-entered into the charts.

Sequence 3: Bones and muscles

Formulation of questions and hypotheses

Objectives :

- **Objectives of notion**
 - Relationship between the site of the bones and joints.
 - Types of connections between bones.
- **Objectives of method**
 - To construct or reformulate questions.
 - To formulate hypotheses.
 - To learn how to represent what is observed.
- **Objectives of attitude**
 - To learn to place in doubt
 - To show imagination.

Progress of the sequence

Recall of the previous sequence and joint formulation of questions and hypotheses:

After posting up the drawings and group written work from the previous sequence, the teacher invites the pupils to read the charts once again.

The pupils are asked to formulate clearly what they think they know and the queries raised. A certain number of arguments are started concerning the hardness of bones, the way in which they are joined together, the nature of muscles and the role they play.

On a wallchart, as dictated by pupils, the teacher writes down:

What we think is true as of today (date) concerning body movements :	The questions we ask ourselves to better understand how our body makes movements:
The bones must be attached	Are bones glued to one another, or attached or fused or interlocked?
There is one bone in the forearm and one bone in the arm. There is a joint between the two	Do bones grow?
Bones are hard and brittle, they cannot be bent	Do we have many muscles? Are there muscles everywhere?
Bones are used to make movements	How do muscles grow?
Bones are straight, but perhaps not all bones.	What is a muscle? What is its purpose?
There is no space between the bones (at the joints).	How do muscles work?

Duration :

Approximately 45 minutes

Material / Preparation:

For the class: drawings and written work from the previous sequence



Remarks

These lists show that some odd questions remain (b and d) whose importance pupils are unable to relate to the problem raised by the teacher: work on the problem-solution approach no doubt not being achieved by all.

A word by the author :

The teacher asks " How can we know who is right ? ".

Pupils suggest looking up the subject in books, the internet, the radio, the Encarta encyclopaedia, asking someone who knows (a doctor for example) by observing a skeleton but this appears difficult.

Since the teacher has the opportunity of finding a skeleton at the teacher training college, this is the solution that is first chosen

Sequence 4: The skeleton

Verification of hypotheses through observation of a skeleton and new questions

Objectives :

- **Objectives of notion**

To know the main component parts of the skeleton.

To relate bones to joints.

To relate limb parts to bones.

- **Objectives of method**

To know how to observe reality and to subject it to questions and hypotheses.

To know how to draw diagrams

To know how to relate reality, imagery and vocabulary.

To know how to structure one's knowledge

- **Objectives of attitude**

To show inquisitiveness and creativity.

Progress of the sequence

Recall of the previous sequence:

The teacher recalls the problem on which the class is working and has a reading made of the chart which was prepared during the previous sequence (see table [sequence 3](#)). The pupils remember that they have to observe a skeleton.

- **Observation of the skeleton :**

Pupils observe the skeleton setting out to reply to the questions asked during the previous sequence. Each pupil draws the skeleton in his/her own experiment book and writes down what they think they have understood.

- **Discussion :**

Throughout the discussion, the teacher introduces the names of the main bones: skull, jaw, spine, ribs, humerus, radius, ulna, femur, tibia, fibula, patella, finger bones, toe bones.

With the teacher's help, pupils formulate what they have learnt and their new queries.

A new argument is entered into, in particular concerning relationships between bones at the site of the joints.

On the skeleton model the bones are joined together by screws and bolts, but pupils are well aware that this is not the case in a living body.

They do not all agree that the skull bone is always hard, with reference to what they have heard concerning babies' skulls (Children often make general use of the word tibia for the leg and conversely).

The teacher enters into a chart as dictated by pupils:



What we believe to be true:	Our queries :
We all have a pelvis	Are the skull bones soft ?
We all have the same number of bones	Are bones attached or interlocked ?
The skeleton is the assembly of all the bones	Can bones stick out from the arm ?
There are bones in our feet: we use them to stand up	Of what use are our bones ?
The ribs are attached to the spine	What is cartilage ? What is its purpose ?
	What are ligaments ? What is their purpose ?

It is pointed out here that it is not sufficient simply to observe reality in order to change one's concepts, and that an investigative observation not only leads to answers but also to new questions.

Together with the pupils, the teacher decides that the investigation must be continued.

X-rays are used to see how bones interlock. Encyclopaedias are used to find the answers to the other questions on bones.

- **Final written record:**

The teacher distributes a diagram of a skeleton to each pupil; pupils must enter the keys using a list of words written on the board; they must write the names of the bones and joints on the left side and the names of the parts of the body on the right side

Duration :

Approximately 45 minutes

Material / Preparation :

For the class: written work from the previous sequence, 1 skeleton, 1 diagram of a skeleton per pupil

Remarks :

It is pointed out that since the launch of the hands on operation "La main à la pâte", some suppliers market small-scale models of the skeleton (Jeulin for example). If no skeleton is available, it is advisable to use photographs of a skeleton before analysing X-rays, an operation which requires prior knowledge and which could be used subsequently as an exercise to apply one's knowledge.

A word by the author :

The written record is the demonstration of the knowledge approached throughout this study, but it is not necessarily a reply to a problem requiring a solution. Replies may be formulated when all necessary verifications have been made and when all elements of reply to intermediate queries have been found; at this point a synthesis could be made.

Sequence 5: A model for simulation

Further clarification and further questions on making a model and dissecting a frog's leg, followed by documentary verification.

1- Objectives :

- **Objectives of notion**

To understand how bones are connected together.

To clearly identify muscles.

To understand how muscles are connected to the bones and how they can actuate the bones.

- **Objectives of method**



To know how to observe, approach reality and subject it to questions, hypotheses even concepts as yet unexpressed.

To know how to build an explanatory model (model, diagram).

To know how to transcribe pertinent elements of reality.

To know how to explain an action or phenomenon.

- **Objectives of attitude**

To show inquisitiveness, creativity.

To integrate into a group by exchanging ideas and dividing work tasks.

Progress of the sequence

- **Recall of unsolved questions:**

Using the charts produced during the previous sequences, the teacher prompts pupils to recall the questions raised and the answers already obtained. It is agreed that it remains to be solved how bones are connected together and what makes the different parts of our body move. Pupils suggest dissecting an animal and conducting experiments (but they are not sure which experiments).

The teacher suggests dissecting frogs' legs and building models so as to try and understand how bones can be connected and actuated.

- **Group work:**

The class is divided into two halves:

- one half divided into groups works on the rear parts of frogs (the flesh has been removed from one of the legs to expose the two bones joined together by ligaments). The children are given a few instruments (tweezers and magnifying glasses).
- the other half divided into groups is to attempt to re-construct an arm (forearm and arm) and to make it work. The pupils are given all kinds of material (wooden sticks, Meccano parts, adhesive tape, elastic bands, string, modelling clay, paper clips ...)

Each group, irrespective of its activity, must be able to represent what it has observed or built and explain what it has understood.

- **Share information:**

In turn, each group explains what it has done and what it has understood with reference to the drawings and written work, and the elements of reply are compared.

The class agrees on what it thinks it has understood at this point and the teacher enters this information into a chart:

- bones are interlocked and joined together by a kind of string which is somewhat elastic (observed on the frogs' legs)
- they can be joined with long strips of adhesive tape (like insulating tape) , there is no need for screws
- muscles are flesh (frog's leg)
- the muscles are attached to the bones
- if you pull on a muscle it is possible to move a bone to which it is attached

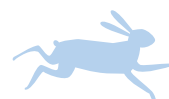
- **Remark :**

Frogs' legs, despite the disadvantage of their small size and differences with mammalian limbs, have some advantages: they are easy to find frozen, children are already familiar with them, the muscles are easier to separate. Later a comparison will need to be made with the human body. This may also help towards generalisation, an important step in conceptualisation. It is to be pointed that the groups who built models only managed to reproduce the joints but not to model the muscles.

- **Document search by groups:**

The class decides to look up their key stage manuals to complete their information and check that they have not made a mistake (2 different manuals per group of 4).

After the group work, pupils enter into their experiment books what they have understood.





- **Pooling:**

The teacher writes on the board what each pupil has to say, helping pupils to reformulate when necessary:

- the ligaments which are a little elastic give strong support to the bones
- the muscles when they contract make the bones move
- the muscles when they contract shorten in length and swell, they become hard

Duration :

Approximately 45 minutes

Material / Preparation :

For the class: written work from the previous sequence

Per group of four:

- **Dissection workshop:** rear half of a frog, tweezers, magnifying glasses
- **model workshop:** wooden sticks, Meccano parts, adhesive tape, elastic bands, string, modelling clay, paper clips

Remarks :

Through this work, it does not mean that they have understood how muscles function, but they seem to have understood that the muscles are the motors of movement.

Sequence 6: Joint synthesis

Structuring and preparation of an explanatory text in connection with language activities.

Objectives :

This session was in fact conducted as part of language work. The pupils used their questions-problems as starting point and constructed an explanation making a synthesis of all the elements of reply obtained during problem-solving activities in Biology.

Progress of the sequence

Final text proposal

Our **skeleton** is made up of 206 bones. They are hard and brittle. It is at the **joints** that bones are able to move in relation to one another. This enables us to make **movements**.

The bones are **interlocked** and held opposite one another by **ligaments**.

To protect the tip of the bones at the joint they are covered by **cartilage**.

It is the **muscles** which enable the bones to move in relation to one another. Muscles end in **tendons** which are attached to the bones.

When a muscle contracts, it swells and shortens in length thereby pulling on the bone and causing it to move

Duration :

Approximately 45 minutes

Remarks :

The teacher may ask pupils to either to construct the entire final explanatory text or provide pupils with a text containing blanks, several levels of difficulty being possible; work tasks can then be differentiated and adapted to respective learning levels.




Outings, developments :

Possible variants according to learning level

- The described experience was conducted with a class of 9 year olds, but with more experienced pupils it is possible to guide them towards identifying the points of attachment of the muscles and understanding the relationship between their location and their role in making bones move. Pupils could be led to forming concepts by locating muscles on a diagram and/or on a model choosing a material to represent the muscles (the bones already being assembled or drawn); in this way pupils can be brought to understanding that tendons cannot be attached anywhere.
- To help pupils understand that it is by shortening that muscles pull on the bones, one young trainee teacher provided pupils with a model she had constructed herself and asked pupils to explain what happens when she made it move. This model was made in thick cardboard, the bones being attached by paper fasteners (the pupils were aware that it was only an artefact) and the muscles were lengths of string surrounded by modelling clay ; these muscles were fixed to the bone with the tacky paste used to post up documents on walls. Therefore when the pupils shortened a muscle while holding one of the bones, they could see the muscle becoming bigger and that it pulled on the bone which was not being held. They could also be introduced to the notion of antagonist muscles.

Another trainee suggested an equivalent model with bones made of sticks of wood connected by mortise and tenon systems.





Classifying Living Organisms (Ages 9 - 11)

Authors: Éric Nicol along with Anne Pichavant, Guillaume Lecointre, Nelly Baccala, Marie-Laure Bonnet, Christophe Lefèvre

Summary: Suggested pedagogical cues for producing, based on a small sample, a tree illustrating the ties between living organisms.

Target Concepts: Evolution of living organisms

Preamble

By giving the children a collection of species to classify, the teacher will be able to convey a number of important conceptual abilities to the children, the first of which is classifying according to what organisms have, as opposed to what they do not have, what they do, where they live, what their use is, or any assumptions as to what they are. In so doing, he will eliminate all utilitarian classifications ("seafood"), anthropocentric ("invertebrate") and ecological ones ("burrowers", "fish") from an approach that aims to be scientific.

Opening Questions

Being familiar with a living organism means, first and foremost, being able to answer the question, "what are its characteristics?", before moving to questions like, "how does it work?" Answering the question, "what are its characteristics?" means, in order, (1) understanding what composes an organism and what it has in common with others, (2) where it comes from and (3) where it fits in the classification. The last two questions can be answered thanks to the first. In other words, it is impossible to define, group living beings and discuss their origin without taking the time to look at what they have concretely. It would make no sense to put them in the same group based on what they do not have: what they do not have can by no means distinguish them and would not be able to testify to their origin. To substantiate this approach with the child, the following starting point can be used: knowing one another means, in part, knowing what one is made of and where one comes from. A child can be asked to attempt to describe a classmate by stating what he does not have, then make groups of classmates based on what they do not have. The results can subsequently be compared with those achieved when classmates are described and put together in groups based on what they have. Very quickly, it can be concluded that the second approach can be meaningful, while the first is not.

The objectives are, over the course of several sessions:

- to describe the species: establish the level of description and bring out the anatomical vocabulary;
- distinguish, classify, sort and order;
- bring out classification criteria to, ultimately, classify on the basis of what living organisms have;
- trigger debate where the observations made and confirmed fact are compared;
- identify organisms that fit together;
- bring out the underlying causality in what they share;
- draw a tree using the combinations;
- classify extraneous species, including fossils, in the already-established classification.





1. Observe and Describe

The first stage is the observation/description stage. For children who are not very familiar with living organisms, begin by describing animals and plants based on photos, in order to bring out the concept of descriptive assertions, then, ultimately, move toward abstraction. This is because a picture of an animal can be viewed for what it is as an individual, or as a representative of an already-assimilated taxon. For example, a robin can be seen as something unknown with a red breast, or as a bird. In description what animals may have, it can be stated that a specific cat is orange, while another is holding a skein of wool. To move toward abstraction, once those descriptions have been made, attempts can be made to sort the generalisable attributes from those resulting from specific situations, by:

- limiting size effects,
- limiting colours by using black-and-white pictures or drawings,
- distinguishing between what is specific to the animals' physical structure and that which is contingent to the photograph.

Show more pictures of individuals from a given species so that the children are later able to perceive what is specific to a species, then remove any repeat images. Ultimately, once size, colour and situation are removed from the picture, the children will be ready to describe species at the appropriate level and broach anatomical vocabulary (head, eyes, wings, hair, feathers, legs, feet, fins, antennae, etc.). The following step is to repeat the same exercise on a sample population of pre-set size, to be classified by the children.

Comment: this session will be radically different if based on an actual sample of species collected in nature. However, the objectives are the same.

2. Distinguish, sort, classify, order

A collection of species (figure 1: a cloth moth, two butterflies, a ladybug, a cockchafer, a beetle, a spotted-gar, a John Dory fish, a man, a rabbit, a cat, a bat, a pigeon and a chicken) is shown in the form of photocopied drawings on coloured paper. The students are asked, in small groups, to sort, classify or order the species, according to the colour of their paper: those with pink paper will be asked to sort, those with blue paper will have to classify, and those with white paper will have to order. With scissors and glue, each group will reorganise the drawings based on what they have to do. Immediately, the concept of criteria will emerge. The sorting criteria will include "has hair" or not, "lives on the farm" or not. The specimen will be ordered from large to small, or from most attractive to most unattractive.

The results are handed in and all posted. You will note that the three groups will have gotten mixed up: some will have sorted, thinking they were classifying, while others will have ordered thinking they were classifying, and vice versa, etc. The worksheets can then be handed out again, in three categories:

- those who sorted:

The species are sorted according to the presence/absence of one or more criteria. For instance, there are the species with hair (cat, bat, rabbit, man) and those that do not (the others). This activity is used in the guides to determining species, but are by no means a classification.

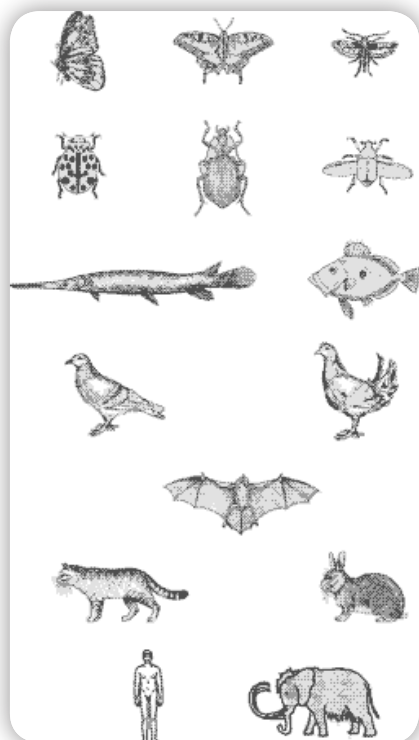
- those who ordered:

The same criterion is used consistently. For instance, the species were ordered from largest to smallest, or from "nicest" to "meanest".

- those that classified:

The groups are designed based on what the species have (rather than what they do not have) and the attributes are referred to as classification characteristics. The characteristics are varied and fit together. For example, amongst those with four legs, there is a sub-group with hair (in which case it is said that the characteristics are naturally ordered). Sets of species that fit together may emerge.





3. Classification: Criteria and Characteristics

Once the sorting and ordering have been completed the actual classification can begin. Initially, the teacher will let the classification criteria emerge, to ultimately recommend to the class that it should classify only on the basis of what the animals have.

If the classification criteria are left to emerge, this will yield a mix of heterogeneous criteria. Animals will be classified together because:

- they do the same thing ("they fly", or "they eat meat"),
- they live in the same place ("they live on the farm"),
- they are (apparently) this or that ("they are insects"),
- they serve the same purpose ("they can be eaten"),
- they are not this or that ("they do not have vertebrae" or "they do not have legs"),
- they have this or that ("they have six legs").

The teacher can let all of the criteria come out, then sort through them with the students.

If the objective is to reach a classification in relation with the organisms' evolutionary history, the teacher will have to tell the students to only classify according to what the animals have (the last of the six criteria above).

The natural tendency will be to only put together disjointed, non-inclusive sets. The second instruction can be to encourage the young classifiers to focus above all on creating sets that fit together. This boils down to prioritising the characteristics: all of the species with hair already had four legs, etc. One way of getting the children started without explicitly asking them to fit the groups together is to ask the classifiers what the animals all have. For example, they all have a head. On the head characteristic, the most inclusive group will emerge. The other groups will necessarily fit into the first.

As far as materials are concerned, the same sheets of paper will need to be cut up, and the children will have to paste the animals into the groups created. In each group, the children will discuss amongst them as to what the animals have. This discussion will lead them to look at the pictures and compare what they know about the





species. Each group of children will produce sets with specific characteristics. For example, the rabbit-cat-man-bat group will combine the hair and nipple characteristics. Each group of children will be asked to draw the sets (in circles, of different colours, if necessary) and to write the characteristics next to the set. Creating set on the basis of multiple characteristics is encouraged.

If necessary, this will lead the children to rephrase their characteristics when they choose an inappropriate characteristic, and bring them back to the anatomical aspects (meaning what the animals have). For example:

- **Inappropriate ("we don't say"):** I am putting them together because they swim (I am classifying based on what they do);
- **Appropriate ("we say"):** I am putting them together because they have fins (based on anatomy);
- **Inappropriate ("we don't say"):** I am putting them together because they are mammals (I classify based on what they appear to be);
- **Appropriate ("we say"):** I am putting them together because they have nipples (based on anatomy).

At a later stage, all of the characteristics of all groups in the classroom will be read out, commented on as a group and posted on the board. For the teacher, the enlarged animal pictures can have been cut out in advance on construction paper and posted on the board using poster putty.

The sets are reassembled using all of the characteristics determined and validated by the class (figure 2).

The characteristics are:

- (cockchafer, beetle, lady bug): elytra (wing-case).
- (butterfly 1, butterfly 2, cloth moth): four wings.

The two previous sets: six legs, antennae, external skeleton.

Pigeon, chicken: feathers.

Cat, man, rabbit, bat: nipples, hair.

The previous set, plus the pigeon and the chicken: four legs.

John Dory, spotted-gar: ray-finned.

The two aforementioned sets: internal skeleton.

All: head, eyes.

Possibly:

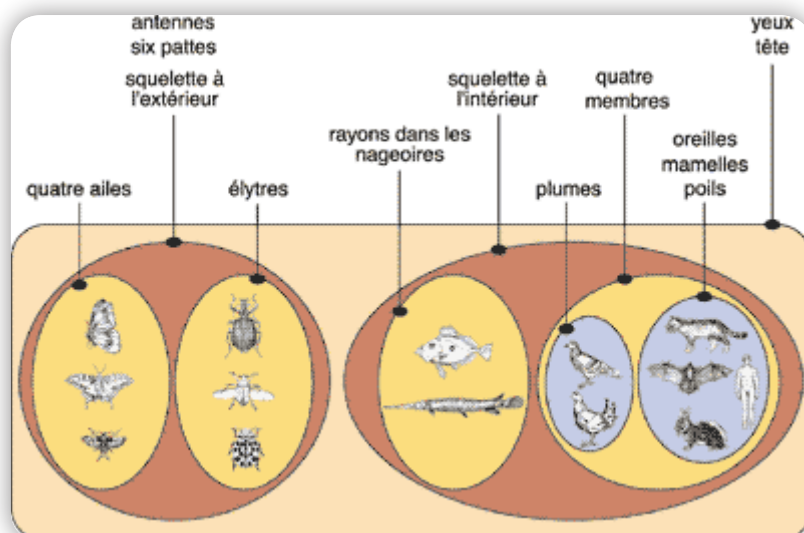
Pigeon, chicken and bat: wings.

The places where the groups fit together are clear.

Note 1:

The bat poses a problem. The children will quickly be thrown off by the fact that the bat has hair and nipples, like the cat, but also wings like the pigeon and chicken. Three options: either the bat is removed from the sample at the outset, or it is suggested that it be classified immediately, as shown here; or it is brought in once the session is over, so as to show the complicated issues only at a later stage. When one of the latter two options is taken, the position assigned to the bat needs to be explained. The rationale used will be based on the concept of parsimony. The class has selected two characteristics for placing the bat with the cat, man and rabbit, while only one characteristic ties it to the bird. It will therefore be placed with the animals for which the largest number of characteristics can be listed.





Four wings – Antennae, six legs, external skeleton – elytra (or wing-case) – ray-finned – internal skeleton – feathers – four legs – ears, nipples, hair – eyes, head

Note 2:

In an initial version of the sample, there was only one bird: the pigeon. The fact that the bird is the only species representing feathers is not a problem as such, and it can be deemed that it is a set on its own. If this is a problem, just add a chicken to the sample, as suggested here.

Note 3:

The basic point of the session is to keep from classifying the animals on the basis of what they are not. Experience shows that, naturally and even without being specifically instructed not to do so, children do not classify on the basis of what animals are not. Closed groups with no scientific value, like “invertebrate” or “agnates” are “cultural pollutants” that are a problem more for adults than for the children.

4. Underlying Causality (the classification says something about the world)

The class can be asked why the species have things in common. The responses are:

- Because God made them that way (if the occasion arises, a definition can be given as to what is specific to scientific assertion).
- Because they are in the same environment.
- Because they make babies.
- Because they are part of the same family.
- Because they are cousins.
- Because they come from the same mother’s stomach, but the mother lived in prehistoric times?

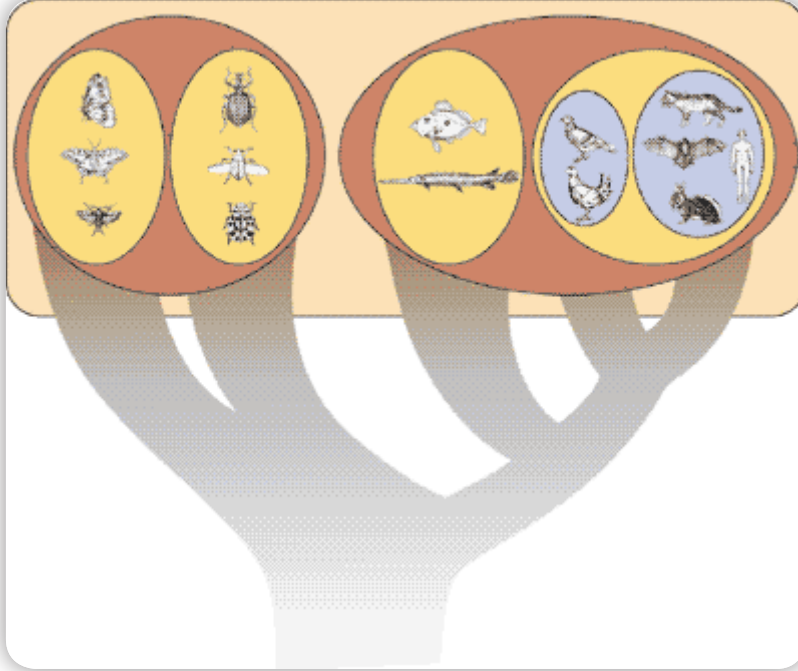
The children can be stirred to recall that their family’s history, as it unfolded over a very long time, is known as genealogy. The term can, in fact, come from the class. What does genealogy entail? Ancestors.

Why are the things they have in common with another species? Because they inherited it from their ancestors, and more specifically, from shared ancestors.

As soon as the term “genealogy” is let loose, the children naturally talk about trees. Some children even say that species change. Behind the sets that fit together, there are animals changing over the course of their genealogy.



Once the key words “ancestors”, “cousins”, “genealogy”, “transformation” or “evolution”, or even “tree” have come out, all of the ingredients are there to explain that, what they have in common (and which others do not have) comes from the fact that inherited the factors from ancestors that are only common to them (meaning they are not the ancestors of other species). For example, the six-legged species come down from an animal that was the ancestor of the June beetle, ladybug, beetle, two butterflies and mite, but is not the ancestor of the others (cat, rabbit, etc.), otherwise the others would also have six legs.



5. From Classification to the Tree

A number of sets closely fit together depict a tree seen from above. Each set is a branch. The more inclusive the set, the deeper the corresponding branch. Two sets at the same hierarchical level are brother groups (figure 3). A series of sets, when projected into the third dimension, becomes a tree.

From a practical standpoint:

1. either the teacher should be left to draw the tree behind the sets.
2. or a mobile shall be used.
3. or a session should be specifically planned so that the children can draw the tree themselves. In that event, a different colour should be used for each set and the corresponding branch will help visually sort through the branches. The student who drew the right tree can be asked to explain his approach, then check that no information was lost in moving from the sets to the tree.
4. or the tree for the sets drawn on the board should be displayed immediately, leaving the children to place the animals at the ends of the branches themselves, in line with the sets, an exercise that necessarily requires their understanding the link between the branches and the sets. The characteristics can then be placed on the tree branches (figure 4). There, it shall be clear that the trees and bats learned to fly twice, each on their own.



6. Placing a new species in the classification

It can be suggested that a mammoth be placed in the final tree. The children just have to check its attributes (characteristics) and place it accordingly: it has a head, an internal skeleton, four legs, nipples and hair. What they can see here is that the fossil will not be placed at a knot in the tree, but at the tip of a branch, like currently-living animals.

Four wings

Six legs – external skeleton

Antennae

Elytra (wing-case)

Head -- eyes

Ray-finned

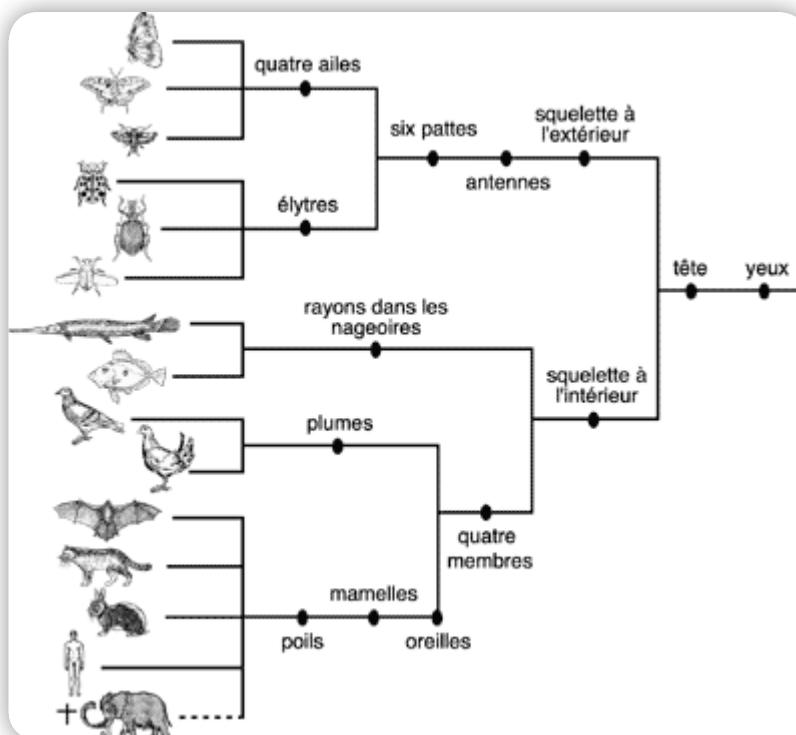
Internal Skeleton

Feathers

Four legs

Nipples

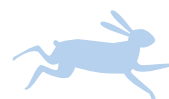
Hair – ears



7. Learning New Words

The aim here is not to teach the children the exact scientific terms, but to ensure that they are capable of defining animal groups put together in the classroom:

- head, eyes: animals (or metazoans).
- six legs, antennae, external skeleton: insects.
- four wings: butterflies.
- wing case: beetles.
- internal skeleton: vertebrae.
- ray-finned: ray-finned fish (or actinopterygians).
- Four legs: four-legged animals (or tetrapods).
- Feathers: birds.
- Nipples, hair: mammals.





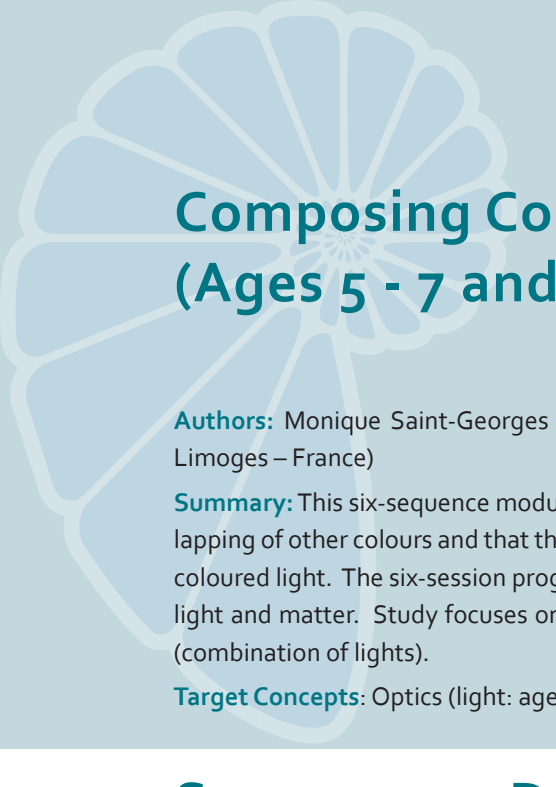
8. Conclusions and Precautionary Measures

This session helped reach a number of objectives:

- Phylogenetic classification was discussed without specific mention being made of it;
- The closed anthropocentric groups were eliminated (invertebrate, agnatha, etc.);
- An approach to classification, moving from observation to classification, was taken, rather than the opposite approach, based on pre-conceptions – when purported knowledge is projected on a perception of the living world, to confirm an often-reassuring by phylogenetically-faulty mental classification;
- it was asserted that a classification states something about the world (transformation over the course of genealogy) and the metaphor of the tree contribute to this;
- the results yielded were compatible with what science produces today.

Tens of different sessions can be invented on this model, depending on the collection of species to be classified. Species can be collected on the seaside, in the forest, along pond sides, etc., and a session of this kind designed with a limited number of samples. However, the main difficulties, for the teacher, will come from striking the right balance between the similarities due to evolutionary convergences, those that are too broadly shared amongst living organisms to serve as a uniting factor in the sample being considered, and those that testify to a true relation. In other words, the risk is that the approach can be successful and well-understood in class, all the while leading a phylogenetically-faulty classification. For instructional reasons, the balance is struck upstream, when the species to be classified are selected. Preparing such a session requires a great deal of advance documentary work: the collections of species to be classified need to be checked, to balance out the difficulties resulting from assertions that are potentially contradictory, and check that those most likely to emerge from the class are actually characteristics that will lead to a phylogenetic classification.





Composing Colours from Matter or Light (Ages 5 - 7 and 8 - 11)

Authors: Monique Saint-Georges & Claudine Comte (IUFM du Limousin, 209 boulevard de Vanteaux - 87000 Limoges – France)

Summary: This six-sequence module aims primarily at teaching the children that colours are the result of an overlapping of other colours and that they can be broken down into separate components, whether coloured matter or coloured light. The six-session progression helps show the differences between the properties, which lie in colour, light and matter. Study focuses on the primary colours used for markers (combination of matter) and television (combination of lights).

Target Concepts: Optics (light: ages 5-7 and 8-11), matter (sample mixtures: ages 8-11).

Sequence 1: Decomposing the Colours of Matter

Summary:

By offering the students the opportunity to test a variety of marker pens, this first sequence will allow them to learn that colours can come from a single colouring agent or a blend of different colouring agents.

Objective:

Show, through chromatography, that a colour can result from the combination of several colours.

Duration:

1 hour, to leave the students the time to test all of the colours in a packet of markers.

Materials:

For each group of 2 students:

- Markers (water-based markers, i.e. Conté brand)
- Strips of filter paper (coffee filters)
- 1 jug
- water

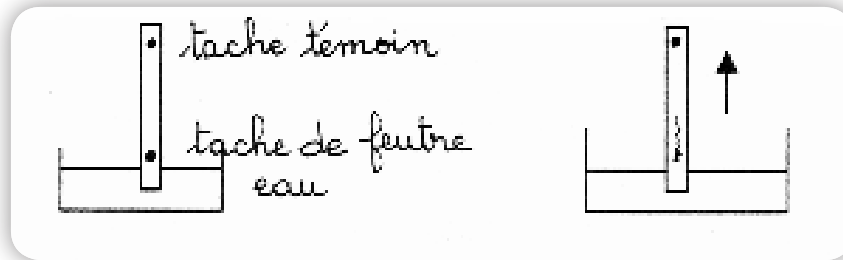
Target Concepts:

- Primary colours.
- Colour blends.



Procedure:

In groups of two, use chromatography on each marker colour.



Control stain

Water-based marker stain

Capillarity makes the water “climb” up the filter paper, bringing the various pigments with it. The pigments separate and deposit at different levels on the strip of filter paper.

Group Analysis:

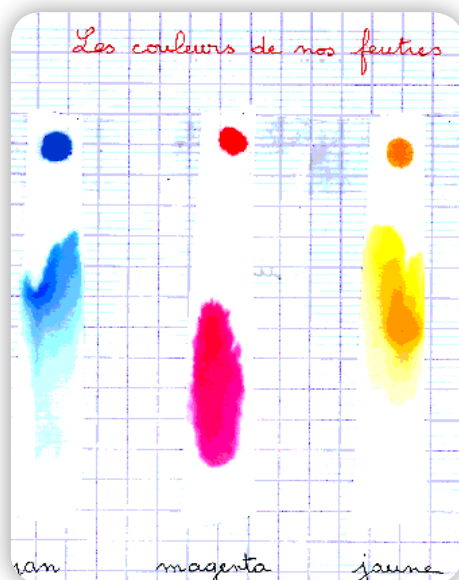
Classify the various chromatographs by number of colouring agents (pigments) that appear for each marker.

The result is:

- one colouring agent for yellow, light blue and pink: these are “pure” colours. They are referred to as the primary colours (yellow – teal – magenta) of matter (Figure 1).
- two or more colouring agents: the darker the colour, the more colouring agents it contains. (Figure 2).

Examples of Student Work:

- Figure 1



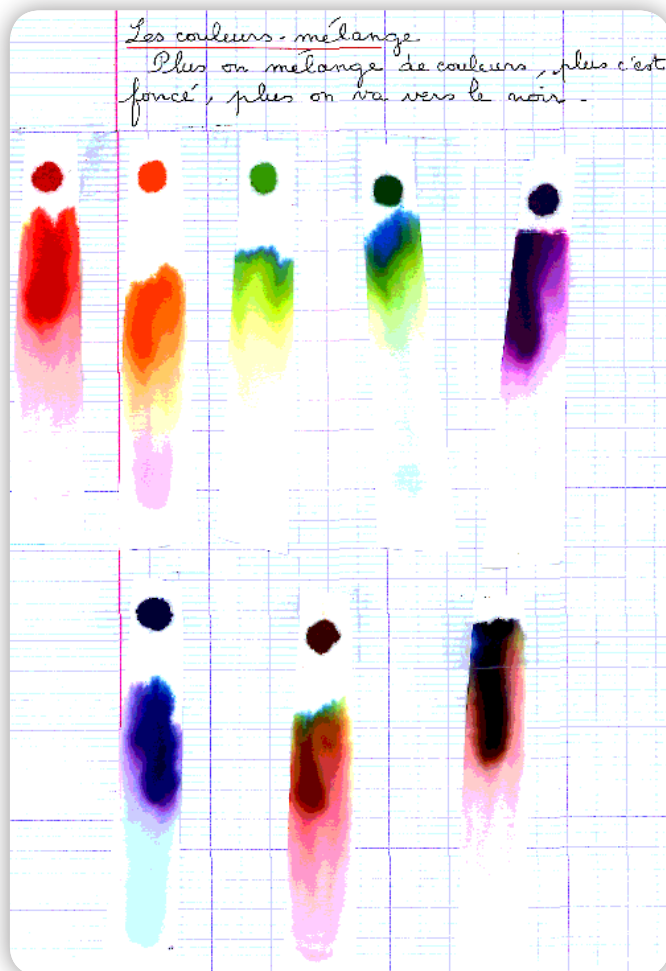
Our Marker Colours

Teal – Magenta – Yellow

One single tint: pure colours



• figure 2



Colours – Blends

The greater the number of colours blended, the darker they are, and the closer they are to black.

Teacher's Note:

This session did not spark any questions about colour, but helped show that certain coloured inks are formed from the three primary inks.

The questions do not come on the scene until the comparison with what is derived from coloured light.

This session, considered in and of itself, is valuable only for the technical colour analysis factor.

There were no difficulties in carrying it out, from the material standpoint, or analysing the findings. Its fun discovery component ("like magic") is very stimulating.

The entry point it provides turns out to be an excellent way to broach the theme of colour.

Sequence 2: Producing Colours - Matter

Using the primary colours identified in the previous session, the students try to make other colours and forecast their results.

Objective:

Use the properties, observations and breakdown results from the previous session to "re-compose" colours.





4

Duration:

1 hour:

- 10 minutes for chance trial
- 35 minutes for trial with predictions
- 15 minutes to summarise (alongside chromatography results)

Materials for each student:

- Markers (water-based markers, i.e. Conté brand)
- Paper

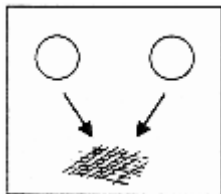
Target Concepts:

- Primary colours.
- Blends of colours.

Procedure:

- **Chance Trial.**

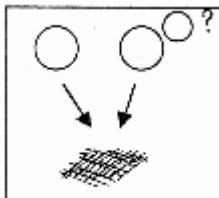
Mix “pure” colours two by two, then all three together



Control stains
Blend
Colour achieved

- **Trial with prediction**

Choose a colour, plan which markers to use to produce it, apply idea, confirm or infirm.



Colour planned
Markers chosen
Blend
Colour achieved

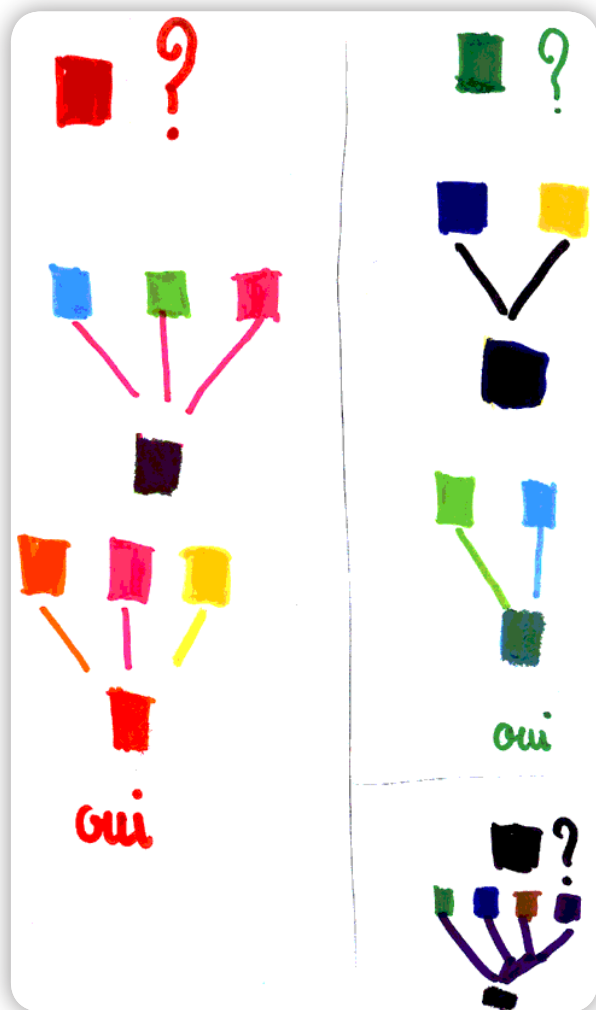
Analysis:

Draw parallel with chromatographs made in previous session, note link between breakdown and recomposition.

Note: the more the colours are blended, the darker they are and the closer they are to black.



Examples of Student Work:



Teacher's Note:

The objective of this session is to put the lessons learned in the previous session to work differently, to make forecasts and check them by actually blending the colours.

However, in the first part of the session, during the "chance" trials, no forecasts are explicitly requested. It is interesting to observe that certain students will already be planning their protocol according to the previous breakdowns.

The evidence they provide enable more systematic forecasts in the second part of the session.

One material issue may hinder the analysis process:

- After a few days, some of the colours from the blends made on paper will fade away (especially the red).
- It is preferable to confirm the forecasts just after they are made, rather than waiting for the next session.





Sequence 3: Colours

The students identify situations that show the “hidden” colours of white light and suggest experiments.

Objective:

Highlight the separation of colours in white light using a dispersive system.

Work on plotting out processes.

Duration:

In two parts:

- 30 minutes in class to identify situations (possible individual research in Library/Document centre or at home).
- 1 hour 15 minutes for experimentation and plotting processes.

Materials:

For entire class:

- 1 CD
- oil
- soap
- water

Note:

Dividing the class into two parts gives the teacher the time necessary to find the materials requested by the children.

Suggested experiments:

- Shine light on a CD with shiny, smooth surface (figure 1)
- Shine light on a stain made of water and oil
- Make soap bubbles in the light
- Light up a prism (figure 2).

For each experiment, the children must determine whether light is essential for seeing iridescence (like rainbows)
Another experiment can be performed:

- Make a rainbow (“Le petit chercheur” Bordas Jeunesse “La couleur” p. 8 and 9)

Procedure:

The students can be put to work in alternating workshops on each experiment, in order to avoid material “overload” (it is better to have one good prism than several ineffectual ones). Each team prepares an experiment, performs it and plots it out to present it to the others. This process helps the children gain self-sufficiency.

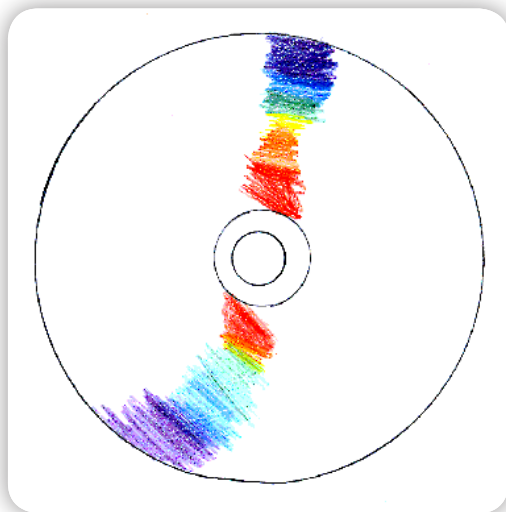
Analysis:

- In all of the experiments, iridescence can be seen when light is shined on the objects. The only shared variable is light. The colours shown are the “hidden” colours in light.
- Attempts are made to determine the colours found (number and tints). The subjectivity of the identification process is emphasised, with each child possibly noting different hues (for instance: orange-yellow or orange-red or orange, etc.). For the 8- to 11-year-olds, six colours will be enough: purple/blue/green/yellow/orange/red.
- The gradual transition from one to the next is noted.

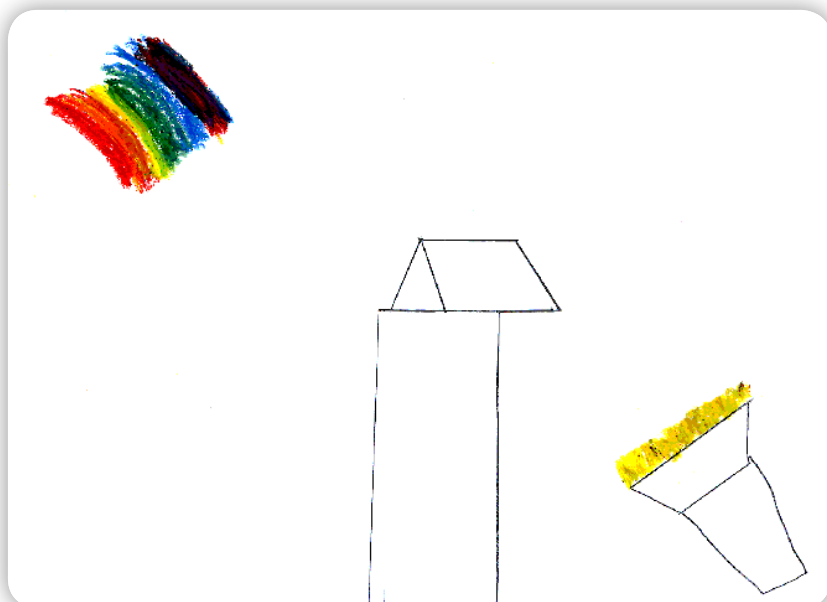


Samples of Student Work:

• Figure 1



• Figure 2



Teacher's Note:

- The children in another class suggested the experiments in a different order. They referred mainly to the presence of water (oil stain on dry ground, soap bubble and rainbow). One question as raised by certain children: "we can't tell whether the colours we see come from the light or the water". Here are some suggestions to make that distinction:
 - 1) turn off the light to look at the soap bubbles
 - 2) set up an arrangement where water plays no part: a Plexiglas ruler, CD, etc.
 Then, the teacher brings out a prism.
- Some difficulties encountered:
 For some children, light and the sun are the same thing. If the sun is not in view (due to cloudy skies, for example), the question, "is there any light?" is asked.
 Vocabulary reviews (transparent, opaque, translucent) were required following the discussions on the role that the clouds play as a screen.
 To anchor that vocabulary, we set up experiments in graphic arts using reused materials.



Sequence 4: Television Light

The students study a television screen using a magnifying glass and identify the colours to recreate all the others.

Objective:

Show all of the “primary” colours in light.

Comment: they are referred to as primary because they are used industrially (on video) to reconstitute all the others. However, this is a choice, as other complementary colours could have been chosen. (The comment is valid also for matter. The primary colours, as commonly taught in drawing, are blue, red and yellow. Yet in printing, the primary colours are blue, red and green.

Duration:

2 x 45 minutes (observing a television screen through a magnifying glass can tire out the eyes)

Materials:

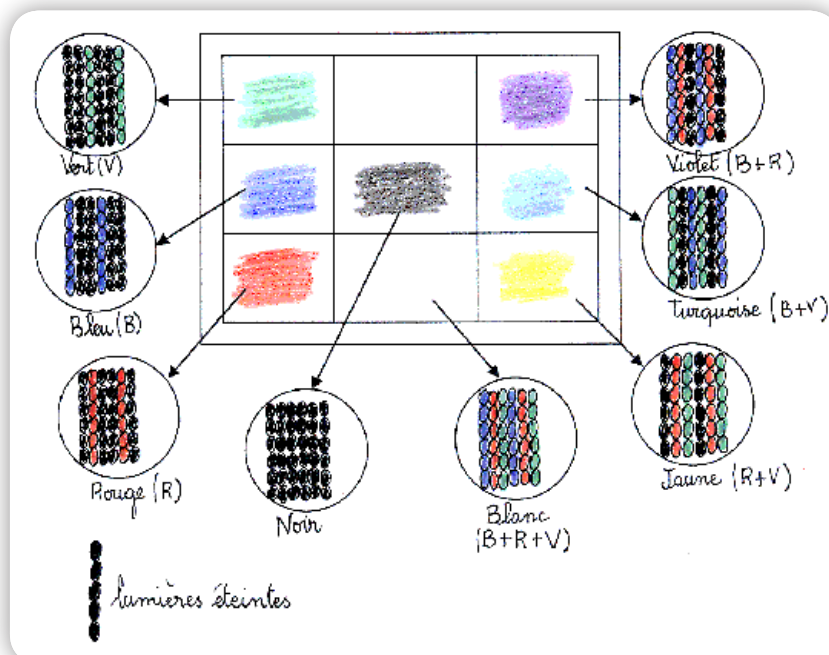
For the entire class:

- a television (frozen or moving image)
- magnifying glasses

Procedure:

The students work in groups of two.

- Undirected observation (30 minutes)
Have each team watch and depict what it sees for each colour. Start with the brightest colours and leave the black, white and, especially, the grey, for the end. (Figures 1 and 2).
15 minutes analysing the results, highlighting the matrix and deactivated bands.
- “Guided” observation (45 minutes)
This time, the students look colour by colour and are asked to fill out the following chart (for each colour, colour the matrix).



Green (V) – Blue (B)– Red (R)– Black – White (BRV) – Yellow (R+V)– Turquoise(B+V) – Purple(B+R)

Deactivated bands

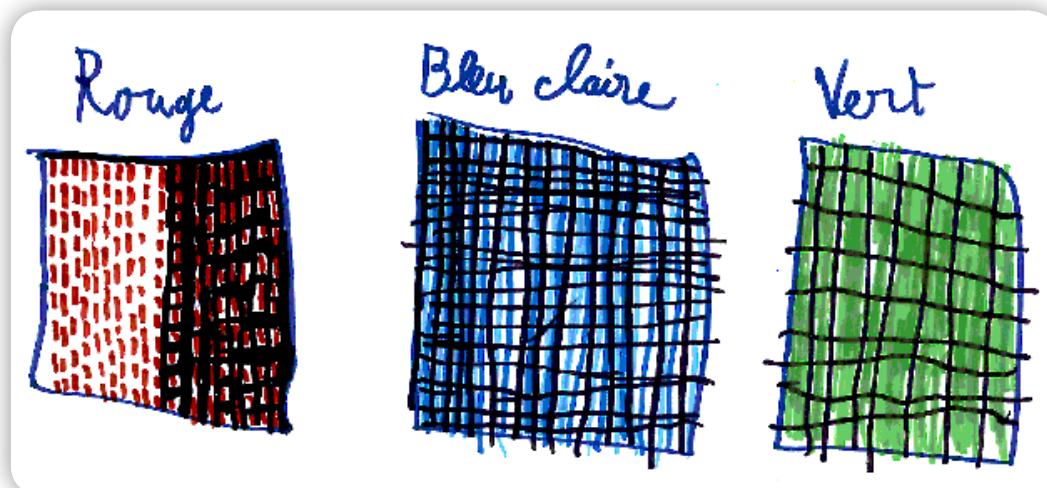


Group Analysis:

- Only three colours are used to make all of the others: green, red and blue.
- For white, all of the lights are lit up.
- For black, all of the lights are turned out.
- Grey is difficult to analyse and seems to offer little value at this stage of elementary school (the intensity of the light varies and it is difficult to identify each colour's contribution).

Samples of Student Work:

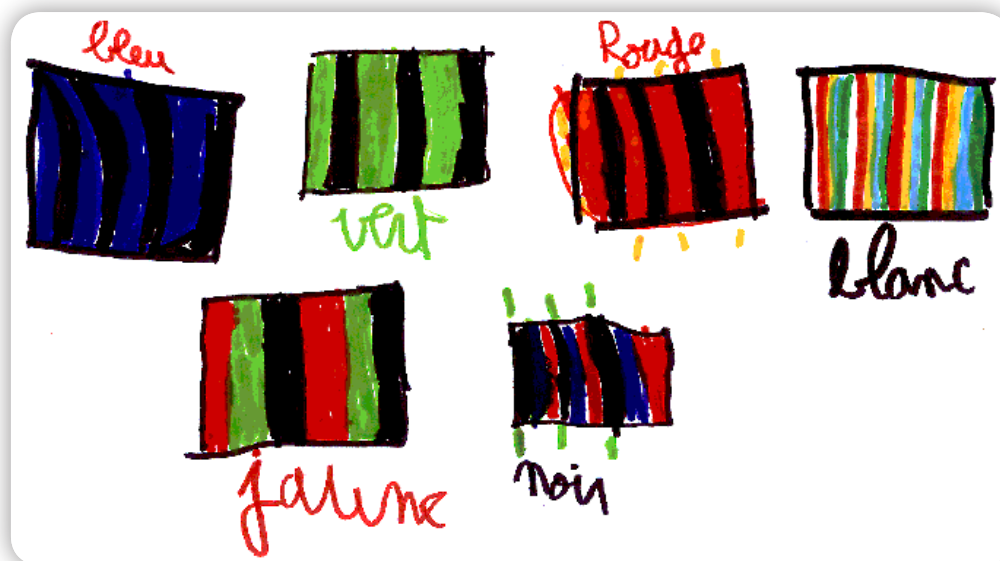
- figure 1



Red – Light blue – Green

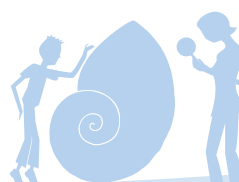
The student sees the matrix-like form, as reflected in the heavy gridding. However, the colours are portrayed as plaids.

- Figure 2



Blue – Green – Red – White

Yellow -- Black



This student did not see the matrix form, as the lines are shown as only vertical. However, the colours are properly shown. The deactivated bands are not always seen.

Teacher's Note:

Difficulties encountered in observation:

- Analysis is highly subjective: it is very difficult to remember what was seen from afar once a magnifying glass is brought in.
- On purple:
As two colours are very similar, the red looks pinker, making certain students draw blue, then pink; in other cases, colours blended in graphic arts led the students astray: blue and red yielded a brownish mixture, while blue and pink yielded a more purple mixture.
- On yellow: the two initial colours were not the ones expected (green and red)
The green was not easily identified because it is very luminous and can give the visual impression of being yellow. It is unexpected and some children replaced green with yellow. Sometimes, it can be found in the drawings, in addition to the red and green.

Sequence 5: Producing Colours – Light

Based on the results of the previous sequence, the students use coloured lights to create other colours, specifying which ones they were able to produce.

Objective:

To use the results from the light breakdown experiment to “re-compose” other coloured lights.

Duration:

Around 1 hour.

Materials:

Per group of 3:

- 3 lamps from the Limoges CRDP (rheostat) (or ordinary lamps) +
- 3 “primary” lamps (blue, red, green)
- cardboard box, painted black or covered in black paper inside
- triangle-base pyramid to be used as a screen

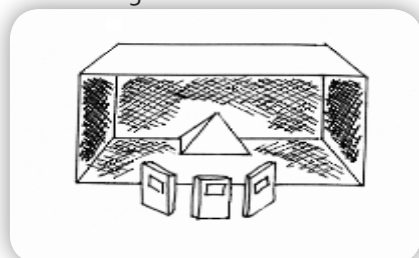
Procedure:

There is enough material for only two groups. While the six students experimented, the rest of the class worked independently in other areas (reading and designing a work plan, for instance).

Each group was given a protocol listing the activities in order. Each team was to manage activities for 30 minutes, choosing to devote more or less time to a specific stage, if necessary.

Unguided testing

To regain familiarity with the properties of light composition covered in the previous session, by freely combining the three lights available.



Producing a specific colour

Choose a colour-light.

Plan which lamp(s) to use to produce it.

Carry out the experiment.

Confirm or infirm.

Record the procedures (in words or drawings).

Make a rainbow

Use the results from one of the experiments to recreate a rainbow. In other words, make purple, blue, green, yellow, orange and red lights, in order and uninterruptedly.

To do so, at the start of the experiment, turn all of the lamps on. Arrange them facing the pyramid-screen. Without moving them, move the rheostat to achieve the amount of light desired.

Results:

- The first phase did not last long in most of the teams.
- Some children began directly with Stage 2, working from the television analysis chart. Most found:
 - R B => purple
 - B V => turquoise
 - R V => yellow (always surprising)
 - R V => orange (varying the intensity: either increase R, or decrease V)
 - R V B => white
- All of the teams managed to create a rainbow. Only one did so by trial and error.

Group summary:

A summary of approximately 15 minutes was used to validate the results and present the process for making an axis-shaped rainbow.

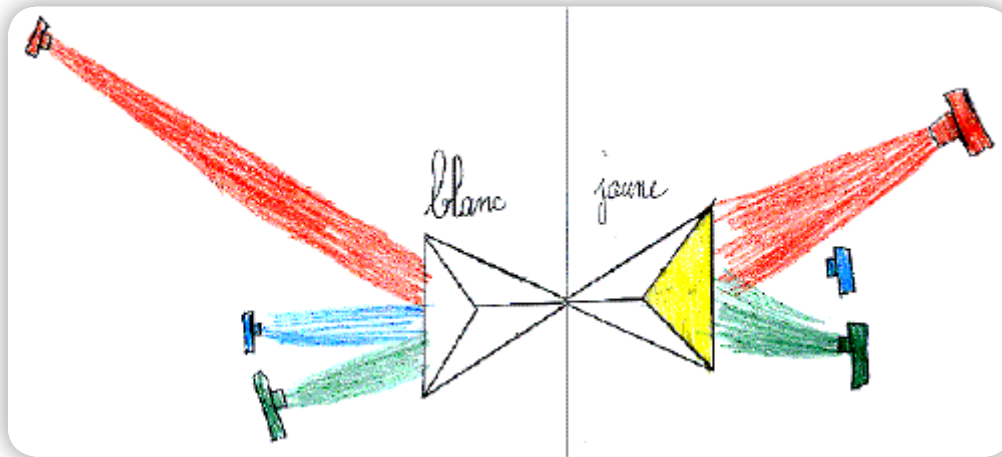
<u>L'arc-en-ciel</u>	Rose ? Violet ?	Bleu	Cyan Turquoise ?	Vert	Jaune	Orange	Rouge
<u>les lampes utilisées</u>	Bleu + Rouge	Bleu	Bleu + Vert	Vert	Vert + Rouge	Vert + Rouge	Rouge
<u>les actions sur les lampes</u>	éteindre Rouge	allumer Vert	éteindre Bleu	allumer Rouge	↑ Rouge et/ou ↓ Vert	éteindre Vert	

Rainbow	Pink Purple	Blue	Teal Turquoise	Green	Yellow	Orange	Red
Lamps used	Blue + Red	Blue	Blue + Green	Green	Green + Red	Green + Red	Red
Action on lamps	Turn off red	Turn green on	Turn blue off	Turn on red	More red and/or less green	Turn off green	

Green, red and blue are the "primary" colours in light. White light is created when these three primary colours are overlapped.



Examples of Student Work:



Teacher's Note:

The children did not manage to agree about what to call certain colours:

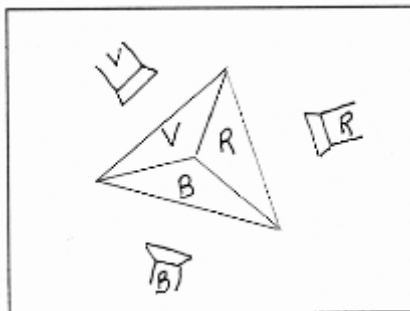
Purple or pink?

Regarding the blue-green blend, some children referred to blue-green, while others said turquoise. Others took on the name teal.

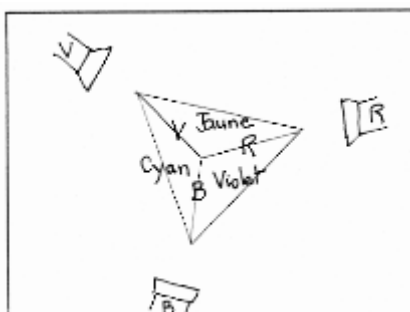
Rather than using the rheostat to vary the lights' intensity, some children chose to play on the distance between the lamps.

Going farther:

It can be beneficial to rebuild the circle of colours in order to observe all the colours in the spectrum and the continuity between them. To do this, put the pyramid-screen box on the ground and take the "overhead view".

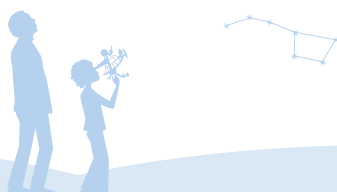


- 1) The lamps light up the sides of the pyramid.
=> the three primary colours can be seen



- 2) Turn the pyramid so that the lamps shine on the edges.
=> on the edges, the primary colours show.
=> on the sides, the matching blends show.
Together, the colours form the chromatic circle.

This additional activity, suggested and implemented by the teacher, lasted around 20 minutes. The children experienced it as an entertaining way of putting their knowledge to work and saw only the aesthetic value.



Responses: Audrey Bonte, teacher (8-11 year old students). Ecole du lac à Château la Vallière (37), abonte@9online.fr: Session 5, with average-quality lamps, did not work well. One of my students then suggested, recalling the multi-coloured tops that are spun around to blend the colours, producing two-tone tops, using television colours (red, green, navy blue). We were able to blend the colours and reproduce what we saw through the magnifying glass, on the television screen.

Sequence 6: Summary

This final session is an opportunity to establish the parallel between light and matter. The students are required to recall the results achieved and properly distinguish between mixtures of light and mixtures of matter.

Objective:

- present everything that was learned about colour.
- Combine the results into a chart.
- Briefly and accurately summarise the activities performed.

Duration:

40 minutes

Materials:

For each student:

- coloured pencils
- paper

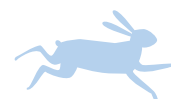
Process:

- Per group of four. For 20 minutes, they worked to produce a written statement fulfilling the teacher's instructions:
 - present all of the lessons learned about colour during the sessions.
 - choose an appropriate presentation format.
- The group summary offered the opportunity to compare and complete the statements.















Teacher's Note:

- From their final year of pre-school, the children are accustomed to using two-entry charts. At several points in their primary schooling, they produce charts of this kind. It is therefore quite natural that their work recalled this format.
- Similarly, being accustomed to processing information, the children did not provide any superfluous details, but rather left some facts out: no intermediate blends, no conclusion.
- The benefits of writing a summary:
 - headings added to columns: light colour, marker colour (to become the matter colour)
 - tying the colour (coloured stain) to the name
 - how to draw white (combination of all coloured lights)
 - intermediate blends

conclusion: since the columns were given headings, a sentence can be listed to summarise.



Group Result

	Matter			Light		
	Matière			Lumière		
Pure colours (primary colours)	 Jaune	 Cyan	 Magenta	 Vert	 Bleu	 Rouge
Les mélanges	J + C ↓	J + M ↓	C + M ↓	V + B ↓	B + R ↓	V + R ↓
Blends						
	J + C + M ↓ 			V + B + R ↓ 		
	+ on mélange de couleurs plus on va vers le noir.			- on mélange de couleurs plus on reconstitue la lumière blanche.		

The more colours are blended
the closer to black they are.

the fewer the colours
blended, the closer to white
light they become





Leaf Decomposition

(ages 5-7)

Author:

R. Bouat (École Saint Marc 41200 Romorantin, 1 rue Paul Besnard, France)

Summary:

Manifestations of life cycle of leafy trees. Becoming aware of leaf decomposition, as opposed to disappearance and their role in the forest.

Target Concepts:

Environmental education => Ecological approach based on immediate environment.

Role and place of living beings, concept of food chains and networks

Materials:

- Identical recipients (20-L plastic boxes with cover).
- Water spray can or watering can with spout.
- fresh leaves
- decomposing leaves
- forest undergrowth (humus)

Scientific Concepts

The life cycle of leafy trees brings about a number of changes over the course of a single year. In Autumn, the leaves can be observed to fall. With time, they decompose. The decomposition of animal and plant matter on the ground brings about the formation of organic matter known as humus.

Scientific Terms

Decomposition, humus

Instructional Approach

Trigger Situation

The leaves fall to the ground in Autumn. A few months later, they have disappeared.

The park gardener gathers the dead leaves and puts them in a heap in a corner of the garden. By Summer, they are gone.

Student Hypotheses

They fly away or disintegrate.

In the meantime, the gardener has put them in the trash.

They are crushed, ground, cut up into tiny pieces and disintegrate.

They go rotten, become all black and turn into soil.

They get eaten up by the animals.

They are destroyed by the rain.

In the classroom, nothing would happen. They need to be outside.

Student-Suggested Experiments

Put leaves into two closed recipients: one outside the classroom, the other inside. Observe on a regular basis.

Use fresh leaves or leaves that have fallen long ago.





Chop up the leaves, put them in a close recipient and wait. Observe.

Put the leaves in a recipient and mix them up with soil. Observe.

Put the leaves in a recipient and water them frequently. Observe.

Use water, soil and leaves at the same time.

Experiments Performed by Students

For each experiment, two recipients are used, in order to facilitate comparison.

- **Experiment 1:** Two recipients filled with newly-fallen leaves. Put on the covers; one is placed outside, the other inside.
- **Experiment 2:** One recipient filled with newly-fallen leaves, the other with leaves that have begun to turn black. Put on the covers.
- **Experiment 3:** One recipient filled with chopped leaves and the other filled with unchopped leaves.
- **Experiment 4:** One recipient filled with a mixture of leaves and undergrowth and the other is filled only with leaves. Put on covers.
- **Experiment 5:** Two recipients filled with leaves. Water just one of the recipients regularly (always the same).
- **Experiment 6:** One recipient filled with a mixture of leaves and earth, the other only with leaves. Water both recipients regularly but sparingly.
- **Experiment 7:** Two recipients filled with leaves. Heat the content of one of the recipients (and bring to a boil for a few minutes).
- Observations are made regularly on the state of the leaves and the appearance of components not visible at the outset (mould, animals, etc.).

Class Organisation

Depending on what point has been reached in the activities, the students worked either jointly, in a group, or individually.

Experiment Notebook

Information sheets are filled out every day.

The group summary will be made once different stages in plant decomposition can be brought out or mentioned : living decomposers (microfauna, mould, bacteria), plant or animal parasites, the influence of humidity and heat, non-modification of content.

Specify whether the daily information sheets are filled out individually or by the entire group. What kind of group writing is used? Is it written on the blackboard or is it a dictation?

Assessment

Over the course of the experimentation, did you assess the students? By watching how they set up their protocol. Observation of experiment implementation by the students as a form of assessment.

Teacher's Note

Prior experimentation in physics can prove very useful to successfully separate the variables selected.

The experiment can last several months and very few changes will be seen during the first 15 to 20 days.

The heat variable was made a requirement, as was the experiment involving the "sterile" environment, with which the children were unfamiliar.

Attention: humidity and heat do not directly trigger plant decomposition. They enable the development or activity of the parasite plants, animals or bacteria that feed on the plants.

These experiments are an opportunity to broach the concept of decomposition but do not make it possible to perceive the importance of living organisms in decomposition.



Documents Used

- "Jeux et activités nature", (Nature Game and Activity Book, French-language version), Paris.
- Environment, Collection 3 R, Vuibert, Paris, 1993.
- Découverte du vivant et de la terre, Anthelme, Dupont, Maurel, Hachette, Paris, 1995.

Outings, Continuation Activities

This sequence can be rounded out by observing the various components present in undergrowth, in order to show the presence of animal and plant matter in the humus. The concepts of ecosystem will be able to be broached and the construction of a terrarium planned.



Raising Stick Insects: Locomotion, Feeding, Life Cycle (ages 5-7)

Authors: Suggested by Claudine CAMPS, with the assistance of the pedagogical team and Jean-Roger RIBAUD (École Sévigné - REP, Avenue des Griffons, 84700 Sorgues, Vaucluse – France)

Summary: A stick insect colony was set up in the classroom so that the students could study their way of life (locomotion, feeding, growth and reproduction).

The world of living organisms:

forms of life in animals

- developing approaches to observation and experimentation
- integrating special vocabulary

Target Concepts:

- birth, growth, reproduction
- nutrition and diet
- locomotion
- interaction with the environment
- "knowing how to manage a colony"

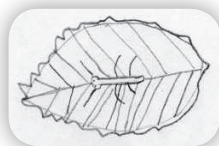
Duration:

The study took place through extended daily observation periods.

Materials:

- Terrarium (small transparent plastic tank)
- Binocular magnifying glass,
- Rulers

Following up on work carried out on language acquisition through science activity last year, in conjunction with the C.E.F.I.S.E.M. (Training and Information Centre for the Schooling of Migrant Children), a Science and the Environment project focusing on language acquisition was set up this year. (See CD-ROM collection, "Where does the Sorgues Fountain's water go" and "Where Does Water Come From", at Web site <http://sevigne.84700.free.fr>), a stick-insect breeding project was set up, after an outing during which the children gathered insect moults. The sequence provided an opportunity to answer the many questions raised by the children. Work on the stick insects was carried out taking a cross-disciplinary approach, using project-based instruction principles that are very stimulating for struggling children.



Scientific Terms:

Stick insects, life cycle, major functions (locomotion, nutrition, reproduction)





Session Plan

Session 1:

Field outing in order to gather samples of living organisms (plant or animal), including stick insect moults.

Session 2:

Learn about different animals: snails, spiders, wood louses, centipedes

Set up structures to keep the animals alive in the classroom (terrariums) and use a Berlese funnel to observe the animals in the litter

A teacher brings in stick insects in relation with moults found.

Session 3:

Children formulate biological problems

Class divided into four groups: reproduction, locomotion, growth, feeding.

Sessions 4 and 5:

Gather answers suggested by students and engage group discussion.

Session 6:

Certain groups look for information on the Internet.

Continue discussion about experiments to implement and their feasibility.

Session 7:

Plan out experiments on paper.

Issue list of experiment and materials required.

Sessions 8, 9, 10, 11 and 12:

Set up and execute experiments.

Bring out new problems.

Session 13:

Report results using posters put up around the school, on this year's CD-ROM "A Forest of Words", in the CP/CE1 insect-raising section and on the school's Web site (<http://sevine.84700.free.fr>).

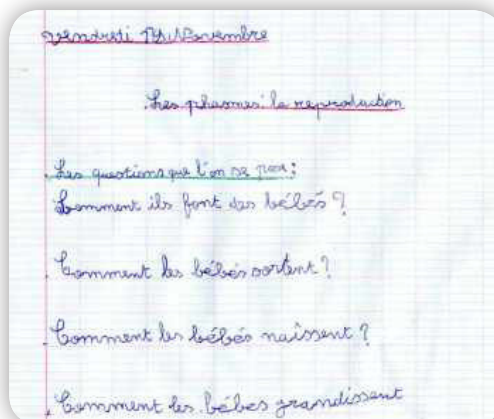
Adjust and modify initial experiments.

The same group works on the same topic.

1. Reproduction Group

Initial questions:

- "How do they make babies?"
- "How do the babies come out?"
- "How are babies born?"
- "How do babies grow?"

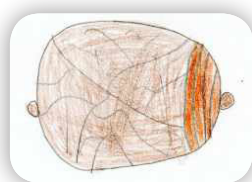
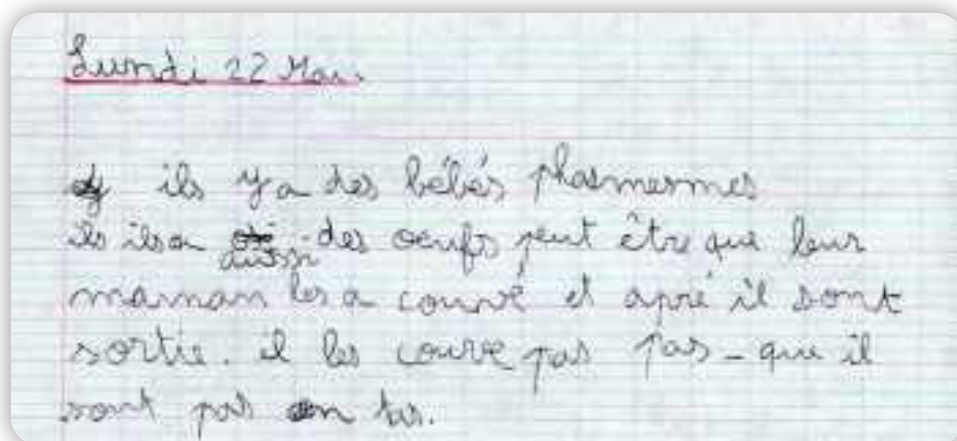


Answers suggested by students:

- "Maybe there has to be a male and a female".
- "Maybe they come together".
- "Maybe the females are green and the males brown".
- "Maybe the babies come out of the female's stomach".

Suggested experiments:

The children suggest counting, every morning, whether there are more or fewer stick insects in the terrarium. They suggest looking at whether there are eggs and looking for the babies.



There are baby stick insects. They also have eggs. Maybe their mommy sits on the eggs and then they came out. He did not sit on them because they are not in a heap.

They note that the number of stick insects remains the same for several months. The issue of differentiating between excrement and eggs (the biological problem that emerged) was solved by using the appropriate observation tools and performing document-based research online.

The students also found information about the sex of the stick insects and their reproduction methods.

The eggs hatched in early June, leaving little time to compare the young insects with the adult ones.

2. Locomotion Group

Initial questions:

- "Do they move around?"
- "How do they walk?"
- "Do they run?"
- "Do they jump?"
- "How do they climb?"

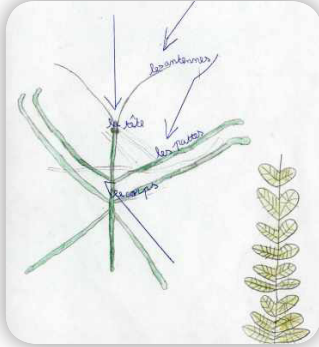
Answers suggested by the students:

- "Maybe because they can't move."
- "Maybe because they walk fast."
- "Maybe because they climb fast."
- "Maybe because they break their leg."



Suggested experiments:

The children suggest studying stick insect anatomy to determine whether they have wings, see if they swim by putting them on the water and see if they fly, by letting them go on a low table.



Antennae / head / legs / body

Following the first experiments, the children suggest colouring the stick insects' legs to observe the path they take over large white leaves. They note that they walk by moving their legs one after the other.

3. Feeding Group

Initial questions:

- "Where is their mouth?"
- "How do they eat?"
- "What do they eat?"
- "How do they bite?"
- "Do they have teeth?"
- "How do they catch their food?"

Answers suggested by the students:

- "Maybe their mouth is below the antennae".
- "Maybe they eat radish, grass, seeds, brambles or bread."
- "Maybe they bite with their teeth".
- "Maybe they grip with their legs".

Suggested experiments:

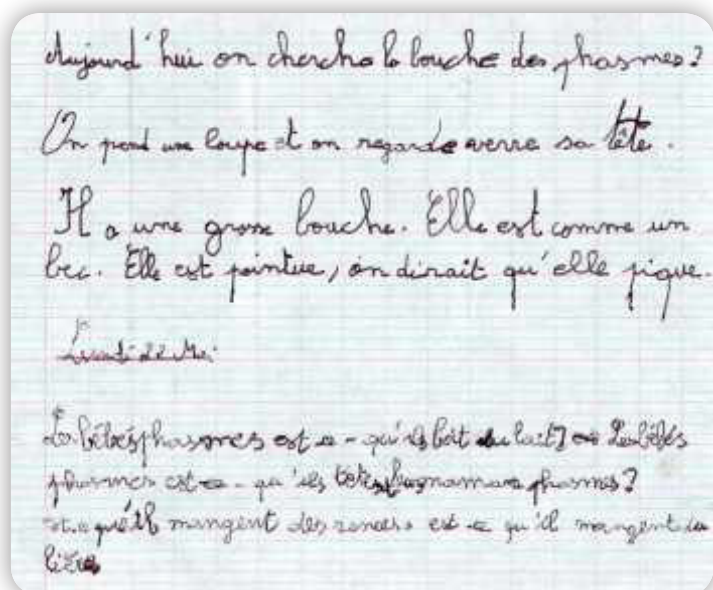
This group suggests a variety of foods to determine their food preferences.

Brambles, the primary component of the stick insect diet, are introduced into the discussion by the teachers.



At the same time, the observations, using magnifying glasses and binoculars, helped better understand the stick insects' mouths. They noticed that the stick insects do not use their legs to eat.





4. Growth Group

Initial Questions:

- "How do they grow?"
- "Do they grow quickly?"
- "Are they all the same size?"
- "How do they get old?"
- "How can you tell if they are dead?"

Answers suggested by students:

- "Maybe they eat at night."
- "Maybe they grow when they eat too much."

The answers do not necessarily come in response to the initial questions.

Suggested experiments:

The group worked from initial questions and left aside all suggestions associating food with growth.

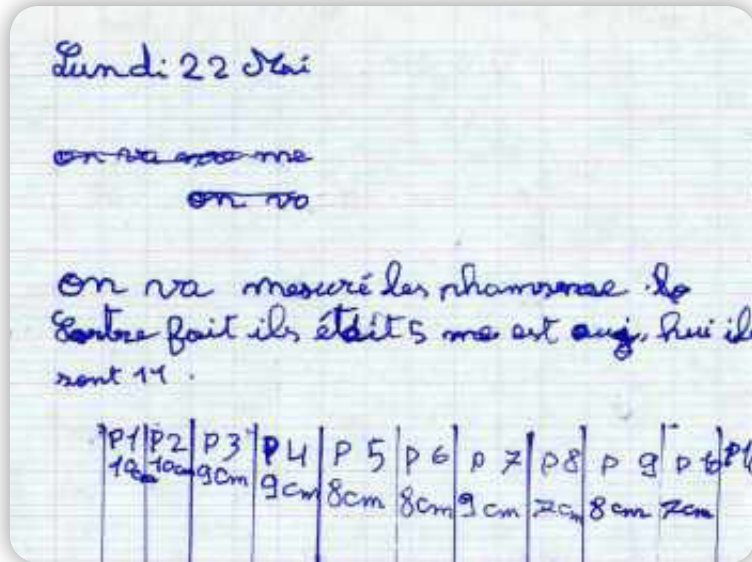
The children suggested measuring the stick insects. However, an additional biological problem emerged very quickly:

How to differentiate between the stick insects to be measured?

The group then suggested either isolating the stick insects in individual terrariums or marking them with food colouring. In the end, they drew a different-coloured dot on their "backs", making it possible to differentiate between them (until the next moult, where the youngest are concerned).

They concluded that: "The stick insects grow up to 11 to 12 cm. Then they lay eggs. To grow, they change skin". (compare with other animals like snakes).





Experiment notebooks

The children were asked how to bring together all of the information regarding the insect colonies.

They suggested a notebook and, starting from that point, the concept of the experiment notebook came into play.

From then on, at every step of the process, the experiment notebooks were used as priority tools.

Assessment

Expanding the children's vocabulary.

Using appropriate vocabulary.

Creating a communications object (le Cd-rom).

Teacher's Comment

The children continued breeding the stick insects at home and thereby gained greater awareness of having respect for animals (respect for ecosystems near the city).

Extensions

Producing a film for training purposes for school teachers (elementary) at the AIX-MARSEILLES IUFM (Avignon site).

PE2-level teachers contributed during Session 7. They observed and filmed the session in the Growth and Reproduction groups.

A CD-Rom and Web site were produced.

The approach was transferred to include other animals.

This year, we are working on organisms that live in the forest bed and the role of decomposers therein (earthworms, ants, wood louses).

La Main à la Pâte comments:

Note: Even though the groups worked separately and on different topics, regular sharing made it possible for each student follow and integrate the work requested of the class as a whole. This enriched the discussion and encouraged the emergence of new suggestions.





Gears (ages 5-7)

Authors

Joint project combining Ecole des Mines de Nantes and primary school teachers (EMN - La Chantrerie - 4, rue A. Kastler - BP 20722 - 44307 Nantes cedex 03 Loire-Atlantique, France, <http://www.emn.fr>)

Summary

4-sequence module to study movement transmission using gears.

Using cogged wheels, the students learn to repair axes and rotation paths.

Programme Points

The world of matter and objects: using common technical objects; assembling and disassembling simple technical objects; designing and producing basic technological objects for utilitarian or entertainment purposes; using battery-operated devices.

Materials

Celda equipment (<http://www.celda.fr>) (or Lego kits) for 6 to 7 groups of four children:

12 base plates, 24 frames, 72 rods, 6 pink cogged wheels and 6 adapters, 24 yellow cogged wheels, 24 blue cogged wheels, 24 red cogged wheels, 6 peg removers, 30 large turning axes, 24 small turning axes, 24 free-running axes, 150 pegs, 24 large pulleys, 24 medium-sized pulleys, 24 small pulleys, 24 axis stands, 24 handles, 63 assorted connecting parts.

As part of a scientific support programme to La Main à la Pâte, with primary schools in the Loire-Atlantique Region, the Nantes Ecoles des Mines has been working in conjunction with teachers, since school year 1996, to produce toolkits containing all of the equipment needed to perform experiments in the classroom, along with a guiding document.

For each topic covered, the document describes a range of experiments and suggests a general sequence of events, list of equipment used and list of required knowledge from the National School Board ("Inspection générale") related to the topic of study. This can be a foundation for setting up science activities, in line with the La Main à la Pâte approach. The general sequence of events is provided for guidance purposes only. Intentionally, the document does not elaborate on the pedagogical approach to be adopted, rightfully leaving it to the initiative of the teacher – the specialist.

This seven-sequence module was taken from the guidance document included with the toolkits.



Sequence 1: Opening Questions

Opening questions about movement (1 session).

Opening Questions (session 1)

Group discussion during which the teacher writes on the board the responses students offer to the following questions:

- What is a movement? What purpose does it serve? Name phenomena involved in movement transmission. What are the various factors that enter the picture? Name different types of movement. What does “a moving object” mean?
- The terms move, travel, go quickly, run, etc., should emerge.

Sequence 2: Studying Gears

Introduction to materials, then use of cogged wheels (or gears) for movement transmission.

Concrete application: studying common objects that use cogged wheels.

Reproduce functioning of said objects with materials (2 sessions).

Session 1: Use of Cogged Wheels

Objective

Learn about the function of cogged wheels as a means of movement transmission.

Invent geared devices, describe how they work and their various parts.

Materials per group:

All of the Celda equipment required.

Procedure

The students are divided into groups.

- Initially, they make attempts with the equipment they chose and the teacher lets them handle freely. This is the equipment introduction phase (around 10 min).
- Then, to guide them, the teacher issues the following challenge: you now have two cogged wheels; make the two wheels turn, with the condition that you are allowed to only touch one.

They must observe and describe as accurately as possible what they have built.

- Lastly, the teacher suggests a group summary to the entire class so that all of the students gain a common scientific culture.

They need to gain vocabulary specific to movement transmission: cogged wheel, cog, crank, movement transmission, pull, gear, turn in one direction, lock in, etc.

Upon completing the session, the students are invited to bring in from home, for the next session, objects from their environment that use the same gears.

Session 2: Concrete Application

Objective

Redeploy knowledge gained in previous session.

Understand the operating mode of common objects using cogged wheels or gears.

Materials per group:

- Celda equipment,
- objects brought in by students.



Procedure

- The students will likely bring in: a hand-held whip, a music box, a salad drainer, a watch gear or a dismountable camera.
- The teacher suggests to the children that they look at the various objects, clearly state how they work (with a drawing, if possible) and classify them according to whether they really have a gear system (some of the objects brought in will not actually work that way). The teacher then asks the children to try to reproduce the movements of some of the objects that work with gears.
- Comments shall be made on the various attempts to check that they do reflect how the objects studied work.

Sequence 3: Use of Gears: Rotation

Using gears and identifying rotation axes

Producing a merry-go-round by using rotations on different yet concurrent planes (2 sessions)

Session 1: Initial Approach

Objectives

- to study gears using a simple merry-go-round.
- identify the rotation axes:
- a rotation axis is vertical when rotation occurs on a horizontal plane.
- a rotation axis is horizontal when rotation occurs on a vertical plane.

Materials per group:

- Celda equipment, in particular for cogged wheels, stands and rods.

Procedure

The teacher asks the students whether they know of games or toys involving gears.

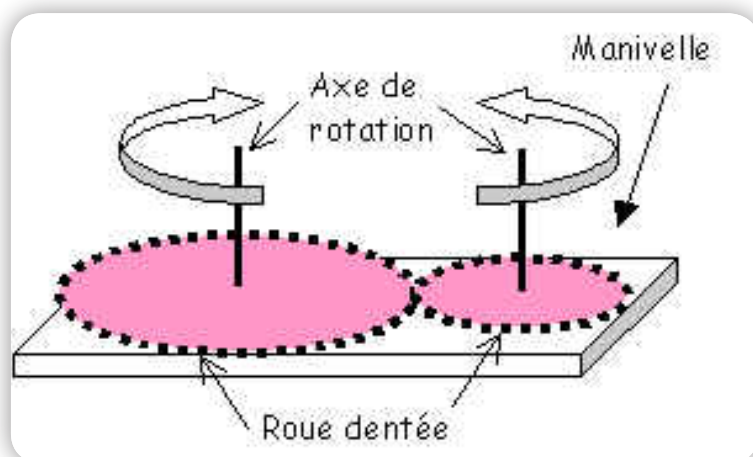
Then he announces to them that they are going to build a merry-go-round (one merry-go-round per group).

First, let them think about how they are going to design their merry-go-round, what equipment will be used, etc.

Then, place some constraints on them:

- using a crank to make the larger wheel turn
- determining the larger wheel's rotation path
- placing several cogged wheels.

Sample suggestion:



Crank

Rotation axis

Cogged wheel





Session 2: the merry-go-round

Objective

To identify rotation axes:

- a rotation axis is vertical when rotation occurs on a horizontal plane.
- a rotation axis is horizontal when rotation occurs on a vertical plane.

Materials per group:

- Celda equipment

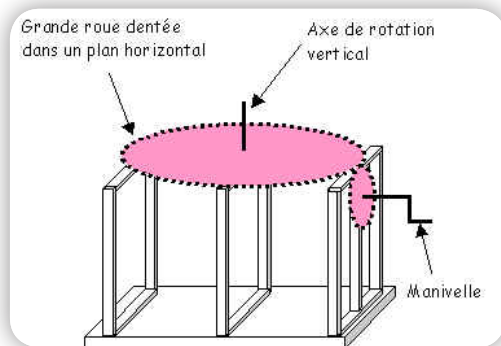
Procedure

The students use the merry-go-round made in the previous session.

The teacher issues an additional constraint: the crank must turn on a horizontal plane, and the large wheel on a vertical plane.

Lastly, the children may decorate the merry-go-round (with animal on the large wheel, and a dome, for instance).

Possible merry-go-round:



*Large cogged wheel
on horizontal plane*

vertical rotation axis

crank

At the end of the session, the teacher asks the students whether they know of ways for making the merry-go-round run without using the crank. Examples include wind, water and electricity.

Going farther: using an energy source

The merry-go-round may be improved using an energy source (water, electricity). The teacher may suggest using an engine or a waterwheel to make the merry-go-round run.

- With an engine

Depending on how advanced the students are, they can be asked to put the engine in the set-up themselves. Then, they are asked to make it turn in the opposite direction.

- With water

The students build pales out of sheets of wood, which will replace the crank. Then, they will have to look at what set-up should be used to make the pales turn.

Sequence 4: Studying Pullies

Studying pullies and how they work.

Comparing with gears (1 session).

Objective

To study pullies and how they work.



To compare pulleys and gears.

Materials per group:

- Celda equipment.

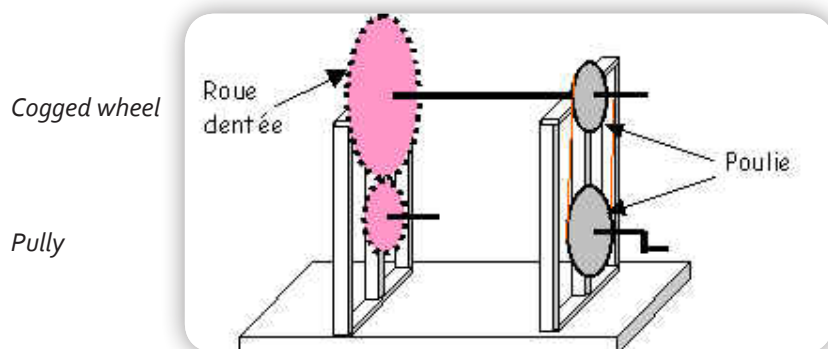
Procedure

The students identify, then explain how a pulley works.

Then, the teacher asks them to compare a pulley with a gear : number of wheels, direction of wheels, how to reverse the rotation direction.

To conclude, an object composed of both a pulley and gear can be made.

Sample:



Going farther

The children can be asked once again to name everyday objects involving pulleys, then describe and draw them.



Breath, Air in Motion

(ages 3 - 4)

Possible Sequence Procedure		
Sessions	Language Activities	Knowledge and know-how put to work
Introduction Several sessions to put to work various means of moving objects and types of matter.	Putting words on objects and actions.	Exercising the body; exercising the imagination.
Active Discovery Session 1. Producing effects with air in motion. Session 2. Making objects move through controlled breathing. Session 3. Transporting or moving. Session 4. Choosing effective blowing instruments.	<ul style="list-style-type: none"> – Using increasingly precise vocabulary. – Expressing success and difficulties. – Enriching others' suggestions with one's own ideas. – Using accurate vocabulary: I inhale, I blow and it moves... Substantiating one's choices ("because..."). – Being able to say that one "moves air" by blowing out or breathing in. – Exchanging about the links between causes and effects. 	<ul style="list-style-type: none"> – Controlling breathing . – Sorting instruments according to their effectiveness Controlling parameters (way of breathing, direction of breath, breathing in). – Redeploying the control gained. – Completing a finalised action. – Being more specific in stating a problem. – Differentiating and sorting instrument according to their effectiveness. – Establish a tie between the effects achieved using human breath and those achieved with instruments. – Recognise the similarity in effect of wind, breath and blowing instruments.
Going further Redeploy previous knowledge and know-how, stabilise lessons learned.	Redeploy previous vocabulary by making suggestions.	Transpose the proficiency developed by adjusting to new situations.
Materials In this sequence, the materials required are water pumps, fans, pieces of cardboard, scarves, straws, stiff tubes, flexible plastic tubes, inflators, bellows, clothespins, papers of varying thickness and shape (very large confetti, candy wrappers, tissue paper, etc.), feathers, recipients, small plats, flexible flasks, a water tank, model sailboats, paper windmills, tinsel, doll clothing, ribbons, paper filaments, raffia cloth... as well as, possibly, what the teacher deems suitable and beneficial.		

The Introduction Stage

By making use of the child's immediate environment and the activities carried out in different areas, the awareness-raising stage gradually prepares the children to broach topics in "learning about the world".

The Body as a Means of Action and Expression – "The Movers"

The children will move objects on the ground, through a set course.

Tennis balls, hockey pucks, rings, scarves and feathers are moved using hockey sticks, rackets and sticks, but also with straws, flexible or stiff tubes, fans and bellows.

This activity enables the students to:

- realise that there exist different ways of moving an object, some using the body and others not (hand, foot, breath, etc.);
- become aware that specific "tools" can be used to replace actions performed by the body, and that they can adjust in order to successfully move an object, by handling the "tools", and watching how they work;
- compare actions and effects, and action-effect relationships.

Blowing out, Breathing in and Observing the Effects Achieved

This activity helps guide the children toward differentiating between breathing in and breathing out; this will be discussed again later.

The activity consists of:

- breathing in, to attract small papers to the straw, or blow on them to move and scatter them around;
- breathing in water (drinking) and blowing into water (making bubbles).



Figure 1. Blowing ink as a drawing technique.

Later, the teacher may add inks, glitter, sand to divide up the colour stains, different materials, and scatter them around or mix them up. The movements, effects and precautionary measures required to remain on the backdrop will be mentioned in the assessment.

Note – Pay very close attention to safety; ink or other products that may be inhaled and thus swallowed shall not be given out unless it has been ascertained that the children have developed enough control over their breathing and movements; even then, measures shall be taken to ensure that the products provided to them are not hazardous. Possible materials include semolina, rice, sugar, salt, cloves, flour, powdered chocolate, alphabet pasta, etc., rather than sand, and syrups (mint, grenadine, etc.), rather than ink, even though the marks they leave, in this case, will not be as easy to discern.

Through this initial observation stage, the children will be able to see that the same effect can be the result of several different causes. Lessons may be enriched by reading picture books and documents.



The Active Discovery Stage

The active discovery stage will be structured around five workshops spanning several sessions, so that each student can take part in most of them, each participating in one workshop per session. One from session to the next, the workshops are nearly identical, but the teacher brings in new directions, in line with the objectives to be attained: the students enter the day's workshop with the lessons they personally learned in the previous workshops and the group learning resulting from classroom work. The teacher always guides the same workshop, from one session to the next.

The objective is to learn about different parameters (how to breathe, air direction, the ability to inhale), verify them and study their effects.

Each session can be organised in several stages:

- at the beginning, the students discuss what was done or observed in their immediate environment during an in-school activity. They attempt to take inventory of the materials offered and suggest ideas for actions to come;
- then, it is time for the activity itself. The teacher explains how the workshops will be organised, research launched, and hands-on activities adjusted to the lessons to be learned, experiments attempted and work instructions;
- group time is the opportunity to hear personal accounts, share impressions and report results;
- in conclusion, the records will be put together into a meaningful format, from drawings to photos, audio recordings, notes taken by the teacher (who will write and reword if necessary, with the children's agreement on the final wording), as a first draft of the final report.

Out of the five workshops, one is directed by the teacher, another is semi-independent (supervised by ATSEM), and three are independent. During the four sessions, the teacher guides the same workshop, making it possible for him to build over time, with all of the students and gradually, the stages through which the children will build their knowledge and know-how. The guided workshop is a special place for language learning, thinking and work on attitudes. In this sequence, Workshop 2 was chosen, as it brings the students to identify and put to work the full range of parameters. Interaction with the teacher is vital in helping them word and reword their suggestions.

Session 1: Producing Effects with Air in Motion

The French game "Flying Pigeon" introduces group questioning. That day, only objects in the immediate surroundings are listed: pencils, scissors, cotton balls, scarves, candy wrappers, rubber bags, gardener's hats, hair, etc.

The players list their choice, "can fly" or "cannot fly", acting out the take-off with their hands. Opinions diverge. Debate can begin.

The Workshops

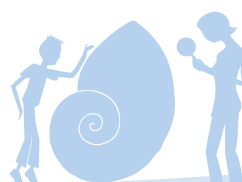
The introduction is both "group time" and an announcement of who will participate in each workshop.

- Workshop 1. Breathing in with a straw to pick up light objects (semi-independent workshop):

Each child is given a straw. The teacher asks, "Can you say what the purpose of this straw is?" The answer comes immediately: "It's for drinking." Several students act out breathing in. The teacher asks for the word that describes the action just viewed; there are no answers yet. He then suggests that the children "act like they are drinking" to pick up the small pieces of papers placed on a plate; the papers can be of different sizes, materials, etc., in order to bring about an adjustment.

- Workshop 2.

Blowing out to move objects as though in a gym (guided workshop): the teacher uses the song "Blow Wind Blow" and states that the children must try to reproduce the effects of the wind on a number of small objects set at a starting line at one end of the table. The experiment involves moving the objects to the starting line without touching them.



The teacher refers back to the games played in the gym: "Remember when we pretended we were movers." Several of the children blow into their hands, while others test instruments to produce air.



Figure 2. Teacher demonstrating how to blow.

- Workshop 3. Blowing out to move model sailboats over water: the teacher states that the boats are not to be touched with the hands: "Use your breath or instruments to move them along".
- Workshop 4. Moving lightweight materials without touching them: the teacher suggests lightweight materials, like crepe, ribbons, paper filaments, tinsel and even pinned up dolls clothing "which are drying for pretend"... "As though all of the objects were outside, in the wind!"
- Workshop 5. Blowing out to make paper windmills turn: several windmill shapes are available to the students.

Student Observations

In the independent workshops, activity begins immediately. In the two others, the adult briefly reviews the introduction, then guides the actions, triggering reactions of all kinds: hesitation, clumsiness, curiosity, hurriedness, dodging, new experiences, progress, etc.

In Workshop 1, the lack of proficiency is an issue: the children do not have an easy time blowing out and breathing in at will. Coordination is unstable and there are some surprises. Some children are unable to change the direction of their breath without a great deal of hesitation and repeated failure. There are unintentional movements, and children blow when they are supposed to inhale, and vice versa.

In Workshop 2, several children have trouble. They have poor control over their breathing. They "splatter" saliva. The feathers remain stuck to the table (maintained there by the children's breath or weighed down by saliva). One student is particularly comfortable. He tests the various instruments and objects, repeats his tests, chooses and object and practices using each instrument. His actions carry him away from the game itself, yet in the end, he states that all of the objects can "stay the course". The other children discard instruments that seem ineffective and repeat their experimentation several times with those that "work".

In Workshop 3, the boats move, turn around and sail forward. Rather than staying with the boats, by walking around the tank with them, the children pull the objects back toward them, then blow again to push them away. By using the straw, then the flexible tube, one child breathes into the water, under the boat. The effect is awesome and immediately copied by the others.

In Workshops 4 and 5, after blowing out through the mouth, the children move objects around by taking them either by one end (materials) or by the handle (objects). They achieve comparable effects, except with the paper windmills. With the latter, one student attempts to blow through the end of the handle.

Group Time

The independent workshops are summed up through demonstrations before the entire class.

A number of experiments are repeated. The teacher comments on the movements used and calls on the group of students in the matching workshop to complete the report.



Once the session has ended, it sometimes happens that the target concepts (varying the intensity and direction of air) have not been formally named.

The students generally discard the ineffective instruments. They still see the process more as a game than a form of research, though this does not prevent them from experimenting or testing.

To enter the field of science, the teacher can ask what the students observed in relation with the initial objectives: breathing in, blowing out, taking action on objects.



Figure 3. Moving objects in different ways.

Student observations

Example, in Workshop 2. Blowing out to move objects as if in the gymnasium.

The teacher: What did you use to move the feather?

The student: The cardboard, then the hand pump, too...

The teacher: How did you use the pump?

Another student: I pressed very hard on it and the feather flew up.

By asking questions about how an object is used, the teacher guides the student toward fine-tuning his expression.

The aim is that the children express cause-effect relationships. Their vocabulary is increasingly precise. A student states that he inhaled. Another adds that he can blow. Another states that "all of the objects move forward, but only with the straw".

The teacher-assisted workshop gives rise to a written statement, displayed on a poster. The experiment account is repeated orally, with the most descriptive statements transcribed very legibly by the teacher, in front of the whole class.

The title of the workshop, date and authors' names are listed. The documents will be used in the following session.

Session 2: Moving Objects by Controlling One's Breath

The session begins with a reprise of the children's song, "Blow Wind Blow". Then, a straw is handed to each student. The action is repeated. This is the time for a vocabulary review: breathing in, blowing out.

The Workshops

– Workshop 1. Breathing in through a straw to move lightweight objects: the text produced as an assessment of the previous session is read and the purpose of the activity is now to control breathing in order to hold the papers for a relatively long time.

The usual recommendations apply here, namely that everyone needs to abide by basic safety and hygiene rules.



Comments are made by the children regarding the straw's relative fragility.

A student shows how he managed during the previous session.

The more hesitant children are encouraged to take part, hands-on: "We pretended to drink... we sucked up the object..."



Figure 4. breathing in to move objects.

– Workshop 2. Blowing out to move objects on a table, taking into account the results from the previous session: new participants will repeat, more or less, the same experiments to confirm the effectiveness of the various instruments. The chart listing the information dictated during the first session is shown and read out loud, and the student who wrote the text confirms the information. He gives further information about his "finds" in terms of how to direct breathing. Some children ask to "race".

– Workshop 3. Blowing out to move model sailboats without sinking them: the teacher asks, "How can we make sure the boats continue to move forward without sinking?" and adds: "I am counting on you to find ideas. The models are fragile."

– Workshop 4. Moving lightweight materials using only breath: most of the objects suggested are the same as those from the previous session. The children are asked not to move them around and to use only their breath.

– Workshop 5. Make the windmills turn by controlling breath direction and intensity: the instructions will be more specific, to invite the students to focus on the desired parameters.

Group Time

Once the activities are completed, personal accounts, remarks and descriptions help bring out conclusions: for example, one student confirms that the straw and plastic tube "work bests in the race, because all of the objects move with them".

The two texts produced the previous time are brought out again and enhanced based on the newly-gained knowledge. A summary of the session offers the opportunity to confirm that the children are well on their way to controlling how they breathe out and in, and direct air.



Figure 5. Making use of the written records.



Session 3: Transporting or Moving

By singing the song, “Gently, Little Boat”, the teacher launches questions about the effects of wind. The discussion closes with the cause-effect relationship summarised hereafter: “To move forward, a sailboat needs wind, just as our models need air”.

The Workshops

The instructions from the previous Workshop 1 have changed. Now, the aim is to transport papers cut out and placed in a dish. “By breathing in, you will transport the papers into the flask”.

Additional materials (for instance, an inflator, bellows, etc.) are presented all at the same time. Later, they will be made available for Workshop 2.

Student Observations

Teacher: What is this?

The teacher holds up a soft inflator designed to inflate mattresses.

A student: It is used to make wind.

Another student: It is used to inflate bicycle or car wheels.

Teacher: How is it used? Show me, then pass it on to your neighbour.

The object is passed from person to person.

It is important to emphasise that the relationship that the children establish themselves between breath and the wind. The idea is to ensure that it is imparted to the entire group, with the benefit of sharing in the large group.

There is a change in Workshop 4. The teacher suggests materials such as glitter, sand and confetti. The aim, this time, is to catch the materials on a spot of glue. This will offer the students the opportunity to experiment with their new skills, by varying the direction and intensity of their breath.

- Workshop 1. Breathing in to transport lightweight objects from one recipient to another.
- Workshop 2. Blowing out to move objects from one end of the table to the other; new materials (guided workshop).
- Workshop 3. Moving the model sailboats without their bumping into one another.
- Workshop 4. Blowing on glitter or sand to catch it on a glue stain.
- Workshop 5. Blowing to help windmills turn very quickly, then slowly.

The children develop independence, and the workshops become increasingly long. The children become committed to continuing the endeavour in each workshop, taking ownership of the progress made by the previous groups. Photos are taken.

Group Time

The final statement on the session is an observation on how breath is produced. The students are capable of characterising and describing the act of blowing and breathing in. Based on their explanation of the issues encountered, the teacher guides the children toward substantiating their choice of a movement or tool in terms of effectiveness, making it possible for everyone involved to go farther in expressing problems and perceiving how air moves.

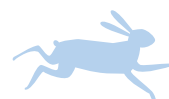
Session 4: Choosing the Right “Blowers”

The purpose of this session is to extend the use of instruments that some people have already handled. At the end of the sequence, a number of objects will be selected for their effectiveness.

The Workshops

In addition to the instructions that applied during the previous session, a number of requirements relating to effectiveness, sparking further efforts to identify cause-effect relations.

- Workshop 1. Breathing in as a means of separating the lightweight objects in several recipient, in order to sort



through them.

- Workshop 2. Choosing the most effective means and the quickest path for moving objects to the edge of the table (guided workshop).
- Workshop 3. Moving model sailboats as quickly as possible (the regatta).



Figure 6. Introducing an inflator.

- Workshop 4. Rounding out and enhancing the work performed the previous week by directing the path taken by the glitter: choosing the right instrument.
- Workshop 5. Blowing to make the windmills or mobiles turn using a variety of blowing instruments.

Student Observations

- Workshop 1: the progress achieved by some students encourages the others to persevere. They change straws, adjust the type of paper to be transported and adjust their breathing. Their approach is to imitate the person who succeeds. The adult oversees their movements, naming what they do precisely and working through the transitions to help those least comfortable. This is where coordination is gained, as the repeated movements yield results. The children are ready to adjust the experiment conditions. They fine-tune the set-up, working on the fundamental parameters (instrument position with respect to the object to be transported, transport optimisation, breath control in terms of intensity and direction).



Figure 7. Object sorting.

- Workshop 2: the imitation introduced by the object race pushes the students to mobilise their skills to succeed. They confirm that the bellows and the inflator are not effective, compared to the straw, which is the most appropriate tool in their eyes. They optimise the straw's position with regard to the object to "go straight ahead".





Figure 8. The Object Race.

– Workshop 3: during the regatta, the aim is to move quickly and prevent collisions. The children combine the techniques and give priority to using the flexible, directional tube, which is longer and more effective than the straw. Its fragility is taken into account.



Figure 9. The Regatta.

– Workshop 4: to catch the various materials on the glue stain, the students test a variety of blowing instruments and eliminate those that are not suitable. This section develops from the records established during the previous session, using their newfound proficiency to abide by the rules learned.



Figure 10. Moving glitter.

– Workshop 5: mobiles and windmills come to life when touched by human breath. To expend less effort, the students give priority to using a number of instruments. They wave cardboard, fans and use the bellows and the inflator.





Figure 11. Making mobiles and windmills turn.

Going Further: Making a Costume

Organised during a party, a costume production activity is organised, using materials that can fly away when exposed to wind. Initially, the children are asked to sort through strips of different materials. The materials selected will have the property of flying away in windy or drafty conditions. Later, the children will attach one end of the strips to a belt and/or a crown and/or a stick. They will be provided with strips of different sizes and materials (paper, textiles, plastics, oilcloth, raffia pile cloth, cork, linoleum, etc.). When a material is considered, testing ensues. The children expose it to drafts, machine and instrument wind, and human breath, before attaching it (glue, staples, tape). In so doing, they redeploy the lessons learned in the previous sessions.

Lessons Learned at Sequence End

- The children now know that they can trigger object movement by moving air (either by blowing air, or using blowing instruments) and use appropriate vocabulary. They establish the relationship between object movement and air movement.
- They control their breathing (in and out) and use “blower” instruments.
- They are capable of transposing and aligning their know-how to solve new problems.



Wind, Air in Motion (ages 3- 4)

The sessions will be organised depending in large part on weather conditions: some activities may take place with the entire class, while others will need to involve smaller teams.

With students aged 3-4, the primary aim will be to help the children explore the sensations resulting from the existence of wind and integrating them into the other significations that they elaborate about the world around them. To do this, it is important to identify what results from the wind, by comparing “the wind” to “lack of wind”, and by helping the children explain how the wind’s effects can be compared to those achieved through direct action or action using objects.

Some of the instructions provided will make it possible to adapt activities to students aged 4-5.

Possible Sequence Procedure			
Sessions	Activities carried out with students	Language activities	Knowledge and knowledge in play
Session 1. Perceiving, expressing, exploring	In this section, the aim is to play in and with the wind, and feel its presence.	Words (from the students and the teacher) help support actions and express emotions. The teacher reads out picture books.	Designate and describe objects, sensations and actions.
Session 2. How can you tell whether it is windy?	Explore the wind using the senses: hearing, seeing.	<ul style="list-style-type: none"> – Participate in group exchange. – Use vocabulary suggested by the teacher to be better understood. – State what one observes. 	<ul style="list-style-type: none"> – Recount experiences. – Observe, identify and name reality. – Recognises components of the aural world. – Explicitly distinguish between what is heard and what is seen.
Session 3. How does wind affect scarves, balloons, etc.?	Observation, description and comparison of effects of wind on various objects: balloons, scarves, ribbon, etc.	<ul style="list-style-type: none"> – Name actions and effects achieved. – Tell of observations made or explain what was done under certain conditions. – State what one intends to do. – Identify, compare and organise depictions (pictures, pictograms) of actions attempted to make wind. 	<ul style="list-style-type: none"> – Observe and describe situations. – Keep a record of similarities and differences between effects observed.



Session 4. How can one make objects move like the wind does?	<ul style="list-style-type: none"> – Put together the lack of wind and immobility of objects already handled. – Look for solutions to set objects in motion, as wind does. 		<ul style="list-style-type: none"> – Establish relationship between cause (wind) and effect (movements observed). – Associate effects of wind and those produced by other actions.
Session 5. How can one have the same effect as the wind in the classroom?	<ul style="list-style-type: none"> – Observe limits of previous answers on smaller objects. – Look for other actions allowed in the classroom to “make wind”. 		<ul style="list-style-type: none"> – First realisation that air is present even when it is not perceived as such. – Adaptation of actions to qualities of objects. – Exploration of technical objects that make wind.
Session 6. Redeployment	Redeploy properties of materials.	<ul style="list-style-type: none"> – Substantiate one’s choices. – Recall experiments, lessons learned. 	Mobilise knowledge and know-how gained in other situations.
Materials <p>The bulk of the materials is made up of objects or materials often already present in the classroom: scarves, ribbon, tissue paper...or easily found (including in stores): straws, heavy-paper fans, rubber bags, feathers, cranks (possibly made by 6-year-old children), plastic or light-weight fabric bags, etc.</p> <p>Special attention is required on the adults’ part, particularly when activities are performed using plastic bags.</p>			

Session 1. Perceive, Feel, Explore

This session is, first and foremost, designed to build up an experience shared by the entire class, and give the children reasons and language tools that will lead them to express and control their feelings, describe, share, compare and question...

It is probably best if the teacher can take advantage of two or three windy days in a row (strong wind, if possible), so that all of the children have the opportunity to engage in dialogue with the adult.

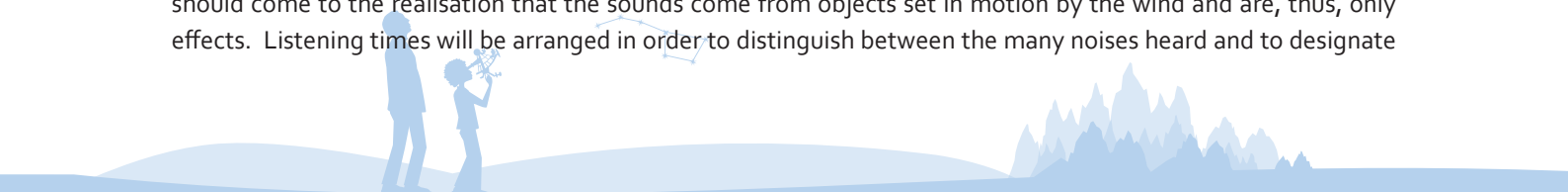
This stage, during which the child becomes familiar with wind as a phenomenon, is an opportunity to extend one’s vocabulary in the specific situation, and through reading a picture book where the children will recognise what they felt. They will also be encouraged to bring object from outside the classroom, or objects they have the opportunity to handle, so that they can look at how the said objects behave in the wind. This will provide fodder for predictions in more structured sessions. The children speak out: “wind stings the eyes”; “it is cold”; “it’s tiring”; “it pushes me”...

Session 2. How To Tell Whether It is Windy

Introduction to Session, on a Windy Day

Before going outside, the teacher, if appropriate, taking advantage of the ritual weather forecast, asks the children whether it is windy today and how they know: “you can see the trees moving”, “you can hear the wind”.

Exchange will be encouraged on this common language construct. Is that really the wind you hear? Or rather the effects of the wind on objects set in motion. By listening to and observing a variety of situations, the children should come to the realisation that the sounds come from objects set in motion by the wind and are, thus, only effects. Listening times will be arranged in order to distinguish between the many noises heard and to designate



them more precisely: “it whistles”, “it makes the shutters bang”, “you can hear it in the leaves”, etc.

Recordings of the most characteristic noises will help review and go into greater depth with the above aural perception activities, by making them a part of other classroom listening times: noises, music, voices, instruments, etc. To initiate the activity, the teacher asks the children, once in the courtyard, to identify everything that moves when it is windy, so that he can take pictures of them.

Possible Observation Exercises and Summing Up

In small groups, the students observe their immediate or more remote environment (plants, objects, clothing, hair, etc.), and choose what is to be photographed by their teacher.

Then, they are brought together for a time of exchange and observation. The teacher helps them convey what they saw and felt, rewording the initial questions and supplying more accurate words to describe certain effects: leaning over, flying away, lifting up... It is also at this time that a distinction is made between the words describing what one hears and those describing what one sees (and has photographed).

Through this process, each component in motion may be identified by the group and recorded by the teacher, so that a selection can be made later, depending on what was observed.

In second-year pre-school, pictograms or coded depictions of the main changes identified can also be set forth, possibly on the basis of the albums (which will also be reflected in writing). This will help establish a tie with the following session.

Session 3. How Wind Affects Scarves, Balloons and Other Items

Session Introduction

The pictures taken during the previous session are handed, with one or two going to each child. The teacher invites each student to post the pictures, adding their comments; he provides assistance in using the previously suggested vocabulary, and encourages children to group the photographs that have meaning.

The teacher then announces another outing, in the courtyard, with objects he will ask the students to name: scarves, ribbons, plastic bags (the children will need to handle them with particular care), rubber bags (inflated and attached to string), long-haired dolls, cranks, etc. He will have the children make projections. “What will happen to...?”

The children are divided into groups and seated, for instance, on as many long benches; they will be responsible for exploring one or two specific objects. The teacher will ensure that there are as many objects as there are children. Each child will be asked to observe “what the wind does to the objects”.

Possible Observation Activities and Summing Up

The children handle the objects and are encouraged by the teacher to express themselves (with suggested precise wording) about what they see: the objects fly away, stand up, the bags inflate, hover, spin, etc.

The teacher takes pictures of the forms of movement observed. He also ensures that each child goes all the way in exploring/handling the objects and encourages mutual assistance between peers.





Figures 12 et 13. Observes the effects of wind on objects.

To bring the outdoor activity to an end, the teacher arranges a sharing time:

- each group shows and states, one after the other, the effects that wind had on its object;
- in second-year class, reference will be made to codes and previously-used statement written by the class.

The teacher helps the students express differences and common points: do all of the objects stand up, and fly away when let go? What do they do when the wind stops? The bags and scarves puff up with air, but what about the balloons? Do they puff up more? (This problem can be explored further at a later stage: “what would need to happen for them to puff up more?” Structuring will take place through the comparisons made between the various activity records (pictures, posters including all of the objects, etc.). The observation sessions will be arranged as a time for reorganising activity records (pictures, drawings, written accounts) around the verbs identifying the main effects of wind. This is a first step in categorising: the wind makes objects bend, fly away, spin, float, puff up, etc.

Session 4. How to Move Objects Like the Wind Does (when there is no wind in the courtyard)

For this session, records from the previous sessions showing the relationship between wind and movement are needed. It is not a vital part of the sequence itself, particularly for the students aged 3-4, and as such, can be skipped. If necessary, it can be carried out in a gym or similar facility.

Session Introduction, on a non-windy day

The teacher announces to the children that, today, they will go into the courtyard to see if the objects move like they did the last time; he will ask them to predict whether the objects will fly away, puff up, etc., as during the previous session.

The teacher does not, initially, call the children’s attention to the presence of wind outside. Once in the courtyard, he invites the children to observe the objects and gradually has them realise that they are not “moving”.

The class will then proceed, as a group, to determine why, with the teacher reawakening memories of previous observations, on objects of course, but also trees and clothing.

Some children are not immediately able to suggest the lack of wind as a possible explanation. Some offer rationale that can be explored for the benefit of the class, revealing what they have grasped up to that point: for instance, “the objects do not move because the wind is not leaning over”. To make the smoke’s position a consequence of the wind, and thereby overcome any possible confusion between the smoke on a day when the wind’s direction has changed, the children will note that the smoke is not going into the trees, but that the trees are nonetheless



moving.

Note – this occurrence is more difficult to make use of than it might seem. Even when the wind is lacking, a puff of smoke can end up spreading out horizontally.

A New Start, New Directions

The teacher asks the children to move the scarves, bags and balloons, along with other objects in the courtyard observed in Session 3, like the wind does. Once the objects are divided up, the children handle them as they wish. The teacher identifies the various actions suggested and helps the students express them precisely: running, jumping, shaking, throwing, etc. Those with bags and scarves have more trouble finding an answer.

Some start running, along a path or in circles, and manage to lift their objects slightly. Others kick dead leaves...

The teacher encourages mutual assistance between the children, in particular to encourage them to tell others about what they have done.

Summing Up

During sharing time, each group suggests the answers it found for its object; the teacher asks the students in other groups to repeat the actions presented and tell whether they produce the same effects on their objects. Based on pictures of the actions carried out and effects yielded, the children will be able to discuss what they did and observed: pushing with one hand, pulling, blowing, shaking, running with...

This will make it possible for them to compare the results achieved through the various actions with those observed as a result of the wind.

The pictograms can be put to use with second-year students, in particular to organise how objects or object portrayals are grouped together.



Figures 14 and 15. Examples of pictograms.

Session 5. How to Make Wind in the Classroom

Session Introduction

Based in the classroom, where the children are not used to being allowed to run or jump, this session aims at reproducing the effects of the wind on lighter, smaller materials: feathers, pieces of paper, strips of silk or fabrics, etc.

The students explore new ways of “making wind”, in particular by blowing, as the objects involved are not generally conducive to such a solution.

Initially, the same materials (scarves, bags, balloons) can be used to convey the idea that “indoor wind” is the same as “outdoor wind”.

As the children are handling smaller and thus more “mobile” objects, it is important that ruckus be kept to a



minimum.

Even if the influence of uncontrolled movements can make it possible to observe interesting effects (air set in motion by a child passing nearby, a draft, etc.), it nonetheless appears preferable to hold the session in workshop format (not all focusing on the same topic), so as to foster relative independence in the children and enabling the teacher to guide and observe the inquiries carried out on various ways of “making wind”.

The teacher can ask the children to predict what would happen if feathers or paper were put in the wind. Often-heard answers include, “they would fly away”, or “they would move”, etc.

The problem is then raised by the teacher: “Inside the classroom, how can we make wind so that the feathers and pieces of paper move?”

Group Work

The teacher guides the children toward discussing solutions found in the courtyard, when wind is lacking, so that they can experience the effect with the same materials: the children observe that the feathers and tissue paper move a bit if shaken or if someone runs around carrying them, but less so than the scarves and balloons.

Other solutions quickly emerge: throwing them up in the air (here, however, it can be pointed out to the children that, rather than “flying away”, or being lifted into the air, the object “fly” as they fall), or blowing on them.

It is important, at this point, to let the children experiment with the solutions they have come up with, as well as with others that will emerge during their activity.



Figure 16. Brainstorming time.

In response to the teacher’s questions about what comes out of one’s mouth when one blows, the children may undistinguishingly respond “wind” or “air”. At this point in the inquiry process, the teacher recalls the previous sessions and helps the children realise that breathing is taking in air – bringing it into the body, then pushing it out. In other words, when a person blows very hard, he makes air rush out and “it’s like wind”, or “he makes wind”.

Likewise, when asked “where the air brought into the body goes”, the first step can be to point out that air is all around us, even if we cannot see it.

The children do not necessarily think to set the air in motion by shaking a leaf or their hand: this is why fans are made available to them, with questions raised as to their purpose; this will help the children understand that it is possible for them to “make wind” or “make air” in groups.

The benefit of introducing other technical objects that make wind will be all the more beneficial if the children have had an opportunity to achieve a degree of familiarity with the objects. Otherwise, it is preferable to keep that aspect for the 6-year-old children.



Summing Up

These hands-on activities help the students understand that, when there is no wind, they can still make some. "I can make wind in the classroom, with the same effects as the wind in the courtyard".

When working with 3- to 4-year olds, it is difficult to reach the more general and structured observation that it is possible to "make wind" by moving air or moving in the air.

Session 6: Possible Redeployment

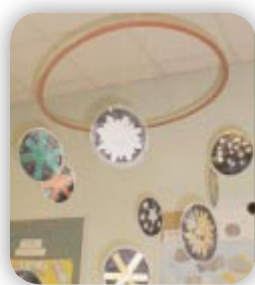
To redeploy and go into greater depth on the previous conclusions and know-how, the teacher can hold mobile-making workshops, during which the children can handle objects and materials that readily move in the wind.

All of the experiments carried out during the previous sessions will serve as reference points to come up with as many solutions as possible for creating (choosing materials, formats and arrangements) and moving mobiles.

Moreover, using photos taken during the various sessions, the teacher can ask the children, individually or in small groups, to classify their actions to "make wind" (blowing, running, shaking, etc.), perform research, in picture books or documentaries, or make illustrations, take pictures or produce pictograms...depicting the wind or options for making wind – such activities will be as many opportunities to re-use vocabulary and review the experiments.



Figure 17.



Figures 18 and 19.



Wind, Air in Motion, – ages 4-5

The implementation plans suggested after Sessions 1 and 2 are not provided in chronological order: they open paths for investigation by going over the questions that may have emerged after the first observations and experiments.

Depending on what the 3- to 4-year-olds will have done, the introductory sessions intended to familiarise the students with wind and wind-related occurrences may be skipped.

Possible Sequence Procedure			
Sessions	Activities carried out with students	Language Activities	Knowledge and Know-How in Play
Familiarisation. How to tell, or how to see that it is windy	<ul style="list-style-type: none"> – Sensory explorations. – Observation of effects of wind in the immediate environment. 	<ul style="list-style-type: none"> – Using more specific vocabulary. – Coming up with precise statements. 	<ul style="list-style-type: none"> – Designating and observing reality. – Stating one's experience and comparing it with that of others.
Session 1. How wind affects various objects	<ul style="list-style-type: none"> Observing, describing and comparing the visible effects of wind on objects. 	<ul style="list-style-type: none"> – Participate in group exchange – Use vocabulary suggested by teacher to convey ideas more clearly. 	<ul style="list-style-type: none"> – Observing and describing situations. – Exchanging about the possible reasons behind the occurrences observed.
Session 2. How to Make Wind in the Classroom How to Make Objects Move without Touching Them	<ul style="list-style-type: none"> – Identifying ways to set fabrics, balloons, sailboats, cranks, etc., in motion – Describing actions carried out and movements observed. – Showing, for the first time, how air is set in motion. – Bringing out other questions, guided by the teacher. 	<ul style="list-style-type: none"> – Naming one's actions, the resulting effects and the mechanisms involved. – Anticipating actions and their effects. – Telling of the observations made or explaining what was done and the surrounding conditions. – Classifying portrayals (pictograms, photos) of the actions performed. – Dictating a text to an adult. 	<ul style="list-style-type: none"> – Predict the results of one's actions. – Trying to understand how an object is used. – Connecting cause and effect. – Trying to explain the result of one's actions. – Raising questions. – Organising objects according to a variety of criteria.



<p>"Blowing" Session</p> <p>What happens when air is blown out?</p> <p>Where does the air that comes out of the mouth start from?</p>	<ul style="list-style-type: none"> – Observing and analysing how the body moves during breathing. – Varying the "power" of the breath or air set in motion. – Using and observing how hair-dryers, pumps, bellows, inflators, etc., work... 		<ul style="list-style-type: none"> – Observing how the body works and naming certain body parts. – Identifying conditions that enable breathing. – Expressing cause-effect relationships. – Classifying objects according to their use.
<p>"Fanning" Session</p> <p>Choosing the most appropriate wind source</p> <p>Going further.</p> <p>Making Objects</p>	<ul style="list-style-type: none"> – Using and observing how fans work. – Holding sailboat races. – Making small cranks based on written instructions and testing them (possible with 5-year-olds). – Making a an that moves and shakes depending on the level of "wind power" (preferably with 5-year-olds). 	<ul style="list-style-type: none"> – Using writing to take action. – Link between picture books and tales: reading and production. 	<p>Comparing technical objects and stating the most appropriate use.</p> <ul style="list-style-type: none"> – Folding, cutting and assembling. – Completing a production. – Reconnecting with the effects previously observed using cranks provided. – Redeploying the properties of materials and objects as part of a graphic arts and sound creation project.

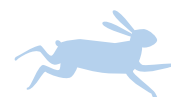
Materials We wish to call teachers' attention to the safety conditions required for handling plastic bags as technical tools. The safety regulations associated with the use of electrical appliances will be set out and enforced by the teacher. The required materials in this session include: cranks, dorade vents, fans (easy to make), boats and buoys (bath) and any object with a sail, anemometers (weathercocks – see elementary school teachers), rubber bags, pumps, hair dyers and ventilator (to be operated with the teacher present). As for the objects to be produced, wooden sticks, thin cardboard, beads (for cranks), cardboard structures, materials of various colours and sizes (for fan), scissors, glue, etc., will be needed.

Familiarisation Session

In the event that the students are broaching the topic of wind and/or air for the first time, their initial conceptions can be gathered during group-class activity, through verbal exchange.

Examples of student responses when asked: "What is wind? How can you tell whether it is windy?"

- Wind is when the trees move.
- It's when it is cold outside.
- The wind pushes the leaves.
- Wind makes trees move.
- When the wind comes, the leaves fall.



– Air is wind. »

Working from those statements, the teacher can bring out a variety of questions and approaches in relation to the curriculum objectives:

- a sensory exploration of wind;
- showing wind as air in motion;
- set objects in motion in the wind, thereby making it possible to establish a shared reference base (knowledge and know-how) on which subsequent inquiries can be based.

Sensory exploration of wind on oneself or on others, and on objects that can be observed around oneself or in the distance is a necessary step. It can be useful to refer to sequences intended more for 3- to 4-year-olds, for suggestions that can be implemented more quickly than with older students.

Session 1. How Wind Affects Various Objects

The objects can be part of the students' everyday environment, but the teacher should feel free to bring in new objects for the familiarisation session, in particular objects usually set in motion by the wind: cranks, sailboats (in tanks filled with water), dorade vents, anemometers, etc. can all be the foundation for research carried out by the students. The technical objects produced by students from elementary school 3 can be tested at this time.

Anticipating Possible Effects

The children predict, as a group, then individually, the wind's possible effects on each of the objects.

The teacher guides the sharing process, providing the vocabulary needed to name, in particular, less familiar components (see anemometer, dorade vents), makes note (for instance, one small card per object) of the suggestions by summarising, to the greatest extent possible, the observations to be implemented and, thereby, make the hypotheses "understandable" to the children when testing time comes.

Experimenting with and Organising Observations

In the wind, outdoors, the children work in small groups, observing how their object reacts and preparing the most precise statements possible to describe what they saw in front of the group. The teacher helps them use their new vocabulary appropriately.

Each group of students must be able to observe several objects.

Back in the classroom, each group tries to categorise the objects according to the movements seen:

- those that fly or fly away (leaves, fabrics, feathers);
- those that spin (crank, anemometer);
- those that puff up (bags, dorade vents);
- those that move forward, either floating or rolling (ping-pong balls, sailboats, sand yachts), for instance by grouping them together on posters.



Figure 20. testing objects produced.



Summing Up

The observations made are compared with one another and with the predictions made based on previously produced written statements.

As this takes place inside the classroom, the transition to the next session is very natural, possibly at the students' request, to check an assertion or dispel disagreement.

Session 2. How to Make Wind in the Classroom. How to Make Objects Move Without Touching Them.

Predicting Solutions

The teacher helps the students spell out the actions to be carried out. There too, he can write all of the suggestions on a small card (one per object).

Suggested student proposals in response to the question: "How can these objects be moved without touching them?":

- the windmill: "you have to run and blow for it to turn"
- the boat: "to move the boat, you have to blow, turn the mill, run around the boat to make air and make it move forward, shake a leaf, shake your hand and spin your hand".
- the dorade vent: "we will blow on it and shake it".
- the anemometer: "you have to run and blow".

Testing the Suggested Solutions

The class shall be divided into as many groups as there are different objects to test (one object being available per student), provided that the activities are introduced with the following instructions:

- the groups shall exchange their objects when asked to do so by the teacher (making it possible for each child to touch all the objects);
- that each child chooses one of the options and tests it. At the same time, the teacher will ensure even unplanned suggestions, arising during the session, have the opportunity to be tested.

While the children handle the objects, the teacher encourages them and helps them express what they are doing and observe the results achieved. He also takes pictures of the actions carried out and the resulting effects.

Exchanging

The first group time immediately following the hands-on phase will offer the students the opportunity to:

- verbally express the result observed, shown as much as necessary through hands-on demonstration;
- compare their observations both amongst themselves and with respect to their hypotheses, and discuss, so as to possibly reach new suggestions or questions to be implemented during further experimentation.

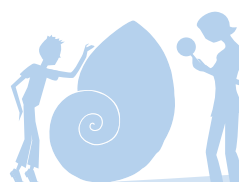


Figures 21 and 22. "Making wind", with a pump or windmill.

Observations made by the children

Dorade vent:

- We ran around and the dorade vent stood up very straight.



- When you blow very hard, it moves a little bit.
- When you shake it very hard, it lies down horizontally.

Anemometer:

- When you blow on it, the anemometer spins around.
- When you run around, it does not turn.

Windmill:

- We ran around and it turned.
- We blew on the front of the windmill and it did not turn.
- We blew on the side and it turned.
- We held it outdoors and it turned (there was a little bit of wind).

The sailboat:

- I blew on it and the boat moved forward a bit.
- I blew very hard on the boat and I won the race.
- I shook my hand and the boat moved forward a bit.
- I blew and the boat got stuck (at the edge).
- I made the windmill spin (with my hand), but the boat did not move.

Summing Up

In summary, this session offers the opportunity to:

- returning to the observations made previously, based this time on the photos taken which, more than an illustration, can serve as a foundation for grouping objects together according to the actions performed (blowing, running, wind) or effects produced (turning, moving forward, lifting);
- interpreting the results observed: when the child moves his hand, the boat moves forward. Based on that observation, the teacher can trigger discussion asking, “Why? What makes it move? With your hand, you make wind. Where does the wind come from? From the courtyard”, but everything is closed. “From my hand”, but when the child stops moving it, he can no longer feel the air. “- why can air be felt on your face when you move your hand?” Because the hand moves the air and makes wind”.

Additional experimentation can be planned based on these conclusions, with an object to be chosen by each student, and for which he will observe that “it’s the same” (“wind can come from this”) when air is moved and when one moves in the air”.

- raising new issues, some of which are listed hereafter, for the following sessions, in two directions: blowing and fanning.

“Blowing” Session

Reflections and Observations on Breath

During Session 2 in particular, the children played with their breathing.

Reflections and observations can be made about breathing at that time:

- “What happens when you breathe? You make air with your mouth and this moves boats, windmills, etc.”
- “Where does the air in your mouth come from? From your stomach”. The children are referring here to breathing exercises done during their singing activity. This is an opportunity to breakdown the various operations and movements involved in breathing: air from the outside is taken into the stomach. The thorax lifts up (“where the lungs are”) because air has entered the body, then it is pushed out when the child blows.

Reflections and Observations on “Breath Force” or Air in Motion

Questions are raised about the “breath force”³ or air in motion: “I blew very hard and the boat moved forward very quickly”.

Reference can be made to the sequence, “Breath, Air in Motion” (ages 3-4 or 5-6) for situations to be adapted,



according to how much the students understand.

Other observations show the connection between how much breath is expended and the resulting effect: for instance, identical rubber bags, all well-inflated and connected at their opening, to pieces of tubing of differing diameter (small, medium, large) will make the sailboats move forward at differing speeds. Through observation and comparison with balls and tubes, the teacher can help the children establish a relationship (which will remain qualitative), as in: "The thicker the tube, the more air comes out and the harder it pushes the boat, which moves more quickly".

This supplementary activity can be introduced and implemented by the teacher or some children designated to "assist" the adult in the activities.

Reflections and Observations On Wind-Making Devices

Using the anemometer outside can help identify the various "wind forces". In handling the instrument in the classroom, the students will have noticed that, the harder they blow, the faster the anemometer spins and the higher it goes. The teacher can offer explanations about how the object is used and works, with the children testing them in the courtyard over the following days.

In addition, the topic of "breath force" or air in motion can bring the children to look for other ways to "make a lot of wind in the classroom", organising sailboat races, for instance.



Figures 23 and 24. How to make the boat move forward...

The children identify, in their immediate environment, objects or devices that can be used to blow very hard, looking through catalogues, pictures and objects provided by the teacher. This is the time to bring in less familiar technical objects: pumps, hairdryers, inflators, etc.

The objects selected will then be tested by the class, operated by the teacher where electrical devices are concerned (this is the opportunity to broach possible hazards) and by the students, in small groups responsible for comparing their "effectiveness" (in terms of speed). The items can be ranked on this basis, from that which makes the boat move the fastest (that which blows the hardest) to that which makes it move the slowest (which blows the softest).

"Fanning" Session

Other objects that do not blow nonetheless yielded the expected effect and "made wind" by making the air move. It is interesting to return to this in a short sequence and, there too, experiment the effects of all or some of the objects on those on which action has already been taken.

In studying how the devices work, the children can "make wind".

- either by agitating or moving the air (ventilator, fan);
- or by taking in the air and expelling it (pumps, breathing).

The children can be made to notice (or state) that the objects work above all because the air they "use" is all around us.

In so doing, the teacher will establish a connection with the sequence, "Is air matter?"



Possible Extension: Making Objects

Making Cranks (4-year-olds)

This is the opportunity to use written indications to make an individual object, which can be used to repeat a number of actions from previous sessions, play in the courtyard (with or without wind) and which everyone can take home.

Making Scarecrows (5-year-olds)

The role of the scarecrow will be explained in greater detail using tales, picture books, etc., but also pictures and reproductions of other works. The scarecrow should move at the slightest breath and produce visual and sound effects that differ depending on the "wind force". The objects or materials will be tested by students using devices that make wind. This will make it possible to integrate relatively large objects into the process, including an anemometer, bells or even metallic objects, etc., depending on what is locally available.

The scarecrows can be set up in the school courtyard or garden, or in plant beds, with the friendly approval of the municipal gardeners!



Figures 25 et 26. Windmills.

« Soufflez monsieur le vent
Faites danser les nuages
Et les cheveux des enfants sages

Soufflez monsieur le Vent
Emportez les papiers
Et le chapeau du jardinier
Fff ! »

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- www.cite-sciences.fr/meteo (Cité des sciences et de l'industrie de La Villette).
- www.meteolafleche.com/vent (site météorologique).
- www.lavoile.com/vent (site des gens de voile).



Making Grape Juice

(ages 4 -5)

In wine-growing regions, this sequence can come after a tour of a vineyard during the grape-picking season, where the students will have seen a professional wine-pressing machine. In other regions, the sequence can build on reflections about the origin of consumer food products: potatoes, milk, pasta, juices, etc.

The sequence suggested is to be carried out in six sessions of varying duration. Session 4b involves several different steps. It can be broken up over time (introduction to technical guides, drawing phase, selection phase, coding phase).

Sequence Procedure			
Sessions	Activities	Activities	Learning Targeted
Session 1. First Attempts at Making Grape Juice	Producing grape juice by hand, then using objects in the immediate environment.	Designating (clusters, seeds, crush...) objects and actions.	<ul style="list-style-type: none"> – Enjoying the act of transforming matter and the “perceptible pleasure” that comes with it – Choosing objects to perform a task (crushing the grapes). – Discussing the outcome achieved.
Session 2. With Other Objects	Producing juice using a variety of objects usually used in cooking, with varying functions.	<ul style="list-style-type: none"> – Exchanging to adjust a movement to an object. – Explaining choices taking into account the outcome. 	<ul style="list-style-type: none"> – Finding the right movements to properly use technical objects. – Helping one another. – Becoming aware of specific hazards and the ability to protect oneself from them; Knowing how to take cautious action. – Trying, comparing and selecting objects according to their effectiveness. – Taking pleasure in becoming proficient in using a technical object.
Session 3. With a Grape Press	<ul style="list-style-type: none"> – Using a specialised technical object: the raisin press – Understanding its workings. 	<ul style="list-style-type: none"> – Exchanging to learn how to put together the parts of a press. – Gaining specific vocabulary. 	<ul style="list-style-type: none"> – Identifying parts and assembling them so they work. – Attempting, trying, concluding. – Identifying the technical functions of a press.

Session 4. Making a Grape Press	Designing and producing a technical object from the materials provided.	<ul style="list-style-type: none"> – Naming actions. – Substantiating choices in consideration for the result. 	Identifying functions and selecting the materials necessary for the press.
Session 4b. Technical guides	<ul style="list-style-type: none"> – Discovering a type of document – the technical guides. – Producing technical guides. 	<ul style="list-style-type: none"> – Learning about technical guides. – Naming the necessary components and steps. 	<ul style="list-style-type: none"> – Selecting the information to be conveyed. Representing it symbolically. – Representing objects and actions. – Assigning oneself selection criteria for the creations. – Accepting responsibility sharing. .
Session 5. Making Apple Juice – Not So Easy...	Redeploying know-how to attempt to make juice with another fruit – the apple.	<ul style="list-style-type: none"> – Explaining ones choices before handling materials. – Expressing issues. 	Trying objects already found to be the most effective in a new setting and looking specifically at why the raisin press failed.
Session 6. Looking for Answers	Looking, trying: the children state hypotheses about the objects they see as most effective for completing the task. They test them and, if necessary, consider other items.	Referring to previous experience to take effective action.	<ul style="list-style-type: none"> – Coming up with suppositions and testing them. – Concluding.

Implementation Conditions

This activity, conducted in a workshop setting with groups of seven to eight children, requires the presence of the teacher, who will have to plan on moving between the various groups. The times for sharing between the groups will, of course, make the sessions unfold differently and thus they will not be totally identical for all of the groups.

Materials for a group of seven to eight children:

- clusters of grapes;
- paper plates;
- cooking items: lettuce drainer, lemon squeezer, garlic press, sauce strainer (a very simple device, with a crank, sold in hardware stores), french fry cutter, pestle, vegetable grinder, crank-operated grater, etc.;
- a household raisin press (possibly replaceable by citrus press). If no such objects are available, in Session 3, a video cassette about the functioning of the grape press can be shown;
- cottage cheese strainer, a variety of boxes (for camembert, cream cheese, aluminium, etc.), wood (a number of pieces, sticks, circles...);
- wood glue, hammer, wooden grater.

Session 1. Hands-On.

Objectives:

- To mobilise the children around the idea of making fruit juice.
- To create awareness, through a variety of trails, that “making grape juice” is feasible, but also that different choices can be made to be as effective as possible.

The aim is essentially to bring the project to life. The children will first take pleasure in crushing the grapes with their fingers, then, under the teacher's guidance, look around the classroom environment for other objects likely to be effective in crushing.

Materials:

- grape clusters, plates and classroom objects.

The children are provided with clusters of grapes and invited to make juice. After a moment of inhibition for some, they will take real pleasure in this.

Here, it is important that the children take action first. It is up to the teacher to gradually being the children to ask themselves questions: how can the juice be caught? Is the quality of the juice satisfactory?

The children begin by crushing the grapes with their fingers (figure 2). Very quickly, the question of where to keep the juice will arise – in a plate or another recipient?

The teacher will then invite them to use other objects in their immediate environment, for example, taking them from the kitchen area (pastry dough roller, measuring cup, etc.). He must accept that the children will use some of the objects in ways not originally intended. The action phase is generally a great success with the children, thanks to the “perceptible pleasure” that comes with transforming matter. It will be up to the teacher to take the experiment farther and have the children compare the observed outcome with the desired result, to stir reactions like Nicolas': “With the measuring cup, we mixed everything up, the seeds, the juice and the skin” (figure 3).



Figure 2. Crushing the grapes by hand.

“We tried to crush the grapes one by one with our fingers to make grape juice.”



Figure 3. Crushing with a measuring cup

I tried to push down on the cluster with the measuring cup to make grape juice. (Nicolas).



Session 2. With Kitchen Items

Objectives:

- To use a variety of objects and identify, for each one, the gesture best suited to its use. This process will involve a great deal of trial, imitation and error. When the children come upon stumbling blocks, the teacher will make them realise where the problems lie (where should they push? Which direction does the crank need to be turned? Where should the grapes be put? Etc.) and encourage the students to help one another to progress. By comparing their intentions with what actually happens and solving a number of problems, the children will have the pleasure of mastering the functioning of a technical object.
- To select objects for their ability to produce juice of sufficient quality and quantity. The objects' effectiveness will not be sought out naturally; it is a factor that the teacher will have to bring out.

Materials:

grapes, plates, lettuce drainer, lemon squeezer, garlic press, sauce strainer, french fry cutter, pestle, vegetable grinder, crank-operated grater.

First of all, the children use the objects. They work toward developing the most appropriate gestures through trial and error. They are often tempted to use the object that works well in a classmate's hands. However, in their own hands, the same object can turn out more difficult to use than they suspected. Mutual aid between the children begin at this point; it is up to the teacher to trigger it, if necessary.

Some objects can be hazardous if not used carefully. By making the children aware of the risks involved, the teacher will also teach them about safety.

The action phase will be followed by a thinking period, in order to select the objects most effective in producing grape juice. The teacher will invite the children to observe the outcome and compare it with what was expected. They will have to reason to make the selection.

With the pestle, "everything ends up mixed up: the fruit, seeds, juice and skin". With the french-fry cutter, "all you get in the plate is juice, but not much". With the lemon press and salad drainer, "nothing happens". With the garlic press, "all you get in the place is juice, but you can only put in one grape at a time". With the grinder, "you can put the whole cluster in, and you end up with everything mixed together – the fruit, seeds, skin and juice". With the sauce strainer, "you can put the whole cluster in, and all you get in the plate is juice".

Following discussion, the sauce strainer is deemed the winner of the "Most Effective" prize. This type of activity also brings in the parents, as they can lend even more effective objects, like a small grape press.



Figure 4. With a pestle or french-fry cutter.



Session 3. With a Raisin Press

Objective:

to introduce the functioning of an object intended specifically for the task to be completed (producing grape juice)

Materials:

a household press (the families can be called upon to contribute)2.

The dis-assembled press is shown to the children. It will be up to them to assemble the parts so that they work. The teacher will guide the process using works to enhance the children's vocabulary. The device's technical superiority (speed, quantity, quality) over the other objects will quickly be realised.



Figure 5. Using the press.

Let's crush raisins with a press. First, we put together the press. Then we put the grapes inside. Then we put the crank on and turned it. It pressed against the plate. The plate dropped down to crush the grape. The grape juice dripped through the whole and, afterwards, it was in the can.

Session 4. Making a Press

First Design, Then Produce

Objectives:

to identify the functions of the object to be produced and look for the materials likely to fulfil those requirements.

Materials:

a variety of boxes (camembert, cream cheese, aluminium, etc.), cottage cheese strainer, wooden circles, sticks, various pieces of wood, wood glue, hammer.

This step requires anticipation, unlike the previous, where action preceded thought. Here, the functions to be performed (crushing and filtering) will need to be identified before the object is produced. The object will be produced by trial and error, as far as selecting the objects and trying to make a pestle (for crushing) and a filtering box that can catch the juice. The teacher's role will be fundamental there too, helping the children explain their



actions, identify problems and look for solutions.

This process can take place with only part of the class, which will present the findings of its inquiry to the group before designing the object (during the next session).

faut : coller un bâton sur un rond en bois.
une boîte percée
boîte en bois



Figure 6. Press made by the children.

Producing a Technical Guide

Motivation for this activity shall come from the need to convey know-how, for instance to the parents.

Before embarking on the session itself, it is best that the students be made familiar with “technical guide” as a document form. This will make it possible for them to produce, as a group, the technical guide to the press produced based on the children’s graphical portrayals:

- review of the actions to be portrayed (“you put the grapes in the punctured box, you put the box in the big box, and you press with the pestle you made”);
- the jobs is shared: the work is divided up between three groups, each with the opportunity to choose one of three actions to depict. Each child in the group produces a drawing. For each drawing, the instructor posts the children’s drawings. They are commented upon, debated over and a selection is made, explaining why those drawings were chosen as essential representations to illustrate the action (figure 7);
- from this point, a common code can be developed for producing the technical guide (the teacher may suggest codes if the children are not successful in doing so – figure 8).



Figure 7. Stages shown by the children.

Session 5. Making Apple Juice

Objectives:

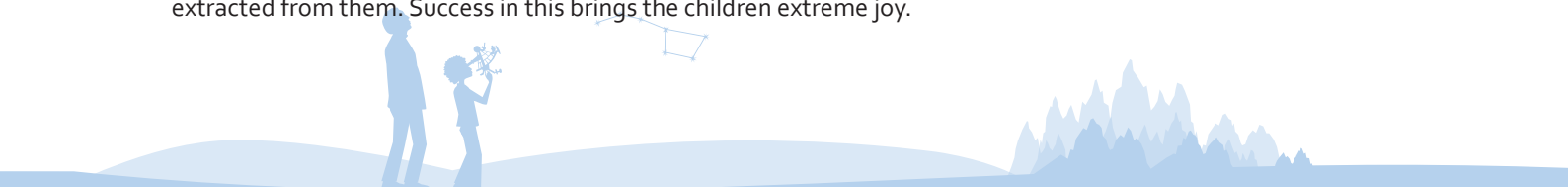
re-deploying know-how and analysing a situation to provide a solution to a problem.

Materials:

apples, the press and the objects from Session (If no press is available, a video or book showing the object may be used.).

The children, asked to produce juice from another fruit, are of course tempted to use the device that was most effective for making grape juice. Unfortunately, the press refuses! (Figure 9)

The failure leads to a brainstorming session: the apples are too big and need to first be grated before juice can be extracted from them. Success in this brings the children extreme joy.



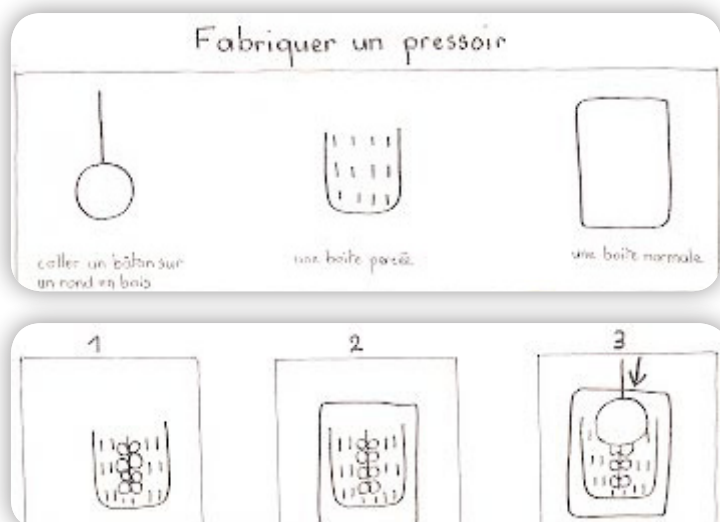


Figure 8. Technical guide to making a press.

Making a press. Glue a stick to a wooden circle. A punctured box. A normal box.



Figure 9. Making apple juice. Kevin put the apples into the press. Afterwards, he put on the plate and the crank. He turned the crank, the plate went down. We didn't make any apple juice.

Kevin a mis les pommes dans le pressoir.
après, il a mis la plaque, la manivelle.
il a tourné la manivelle, la plaque a descendu
on n'a pas réussi à faire du jus de pomme





Sink or Float

(ages 5-7)

Authors: Joint effort between Ecole des Mines de Nantes and primary school teachers. EMN - La Chantrerie - 4, rue A. Kastler - BP 20722 - 44307 Nantes cedex 03 Loire-Atlantique <http://www.emn.fr>

Summary: This seven-sequence module offers the opportunity to study the floatability conditions for various objects. The students will learn that it is not a matter of mass, but rather volume. The effect of spring water on the object is broached thereafter, then compared to that of saltwater.

Target concepts: The world of matter and objects; water in everyday life.

Objective: Since the start of school year 1996-1997, Ecole des Mines (Nantes) has been involved in a science education project, La Main à la Pâte, putting together toolkits (with all of the material needed to perform experiments in the classroom), as well as a guidance document.

For each topic covered, the document describes a range of experiences and suggests a general sequence of events, list of equipment used and list of required knowledge from the National School Board related to the topic of study. This can be a foundation for setting up science activities, in line with the La Main à la Pâte approach.

The general sequence of events is provided for guidance purposes only.

Intentionally, the document does not elaborate on the pedagogical approach to be adopted, rightfully leaving it to the initiative of the teacher – the specialist.

NB: The seven-sequence module was taken from the guidance document included with the toolkits.

Materials: For a class of 30 (7 groups):

- 7 plastic bins
- 49 empty canisters (camera film size)
- 7 pieces of transparent tubing ($\varnothing = 6$ mm, L = 40 cm)
- 14 plastic cups
- straws
- clay
- string
- rubber bands
- 7 steel nails ($\varnothing = 5$ mm, L = 15 cm),
- salt
- 1 rock (to be brought from home)
- 1 small fishing pole or bendable wooden stick (to be brought from home)
- 20 1.5-L plastic bottles (to be brought from home)
- 10 0.33-L or 0.5-L small plastic bottles (to be brought from home)
- 7 jam jars (to be brought from home)
- a variety of materials: sand, seeds, rice, flour, cotton, etc. (to be brought from home)
- 1 Roberval scale.

Sequence 1: Pretest

Have children discuss and draw in order to bring out children's pre-conceptions.

Check hypotheses about object floatability selected by students (2 sessions).

Objective: To bring out children's pre-conceptions regarding what floats and what sinks, as well as floatability criteria.

Materials (per child):

- one piece of paper

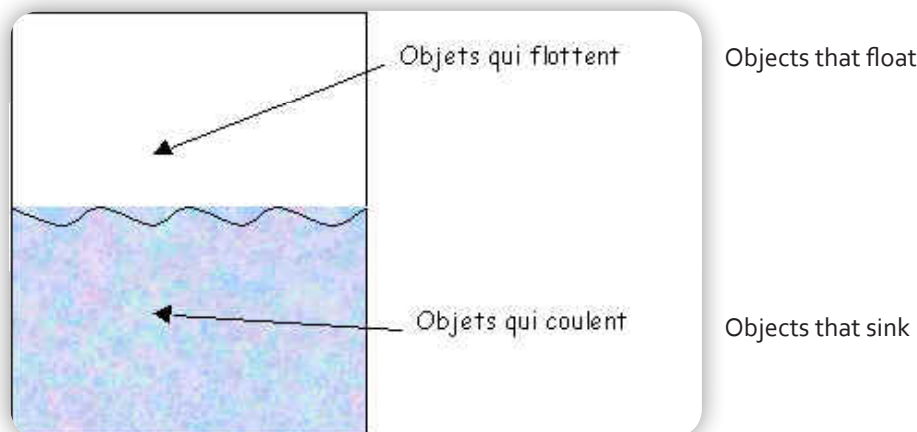
Materials (per group):

- various small classroom objects: pencil, scissors, nail, piece of wood, rubber band, cork, plastic, etc.
- 1 bin half-filled with water.

Session 1

The session begins with a discussion: what is floating? Do you know of any objects that float? What is the opposite of floating? Later, a number of everyday objects are shown (pencil, scissors, nail, piece of wood, rubber band, cork, rock, plastic, etc.) to the children. The children are asked to draw the objects that float and those that sink on a piece of paper showing a side-view of a bin filled with water.

Example:



At the end of the first session, all of the results are pooled. Discussion can focus, for instance, on where the objects are positioned in the drawing (at the surface, at the bottom of the bin).

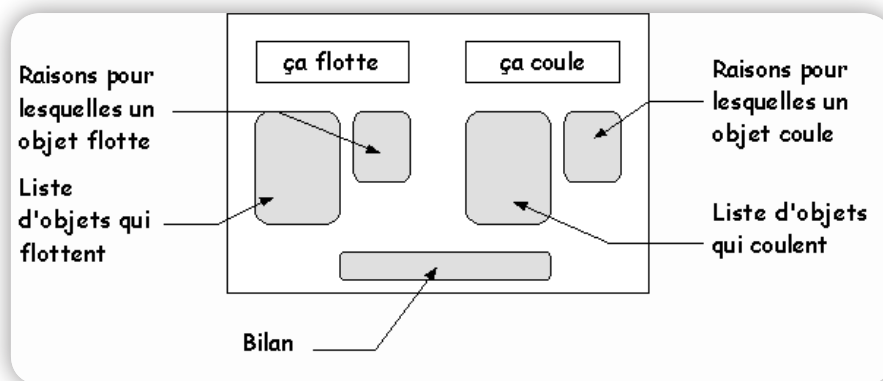
Session 2

After reviewing the results from the previous session and, in order to check the children's hypotheses, experimentation begins.

At the end of the session, a discussion takes place to identify some of the criteria for floatability: each of the objects used during the experiment is reconsidered and the children are asked to explain why each floats.

To conclude the session, a large poster can be set up with the children:





	<i>These float</i>	<i>These sink</i>	
<i>Reasons why an object floats</i>			<i>Reasons why an object sinks</i>
<i>List of objects that float</i>			<i>List of objects that sink</i>
	<i>Conclusion</i>		

The conclusion at the bottom of the poster will highlight the most important criteria, in the children's view, for which an object floats or sinks (matter, object mass, shape, amount of water, etc.).

Sequence 2: How an object's shape influences its floatability

Sequence 2 in Sink or Float module: Two objects with the same mass do not necessarily have the same floatability. It depends on their shape (1 session).

Objective: To compare the floatability of 2 objects with the same mass, but different shapes, and touch on the influence of the space occupied by the object in the water.

Materials (per group):

- modelling clay,
- a bin,
- a jam jar

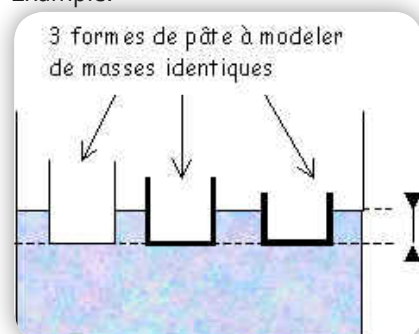
Materials (for the class) :

- a scale.

Procedure

The children are asked: "In your opinion, if two objects have the same mass and one sinks, will the other sink too?". The children experiment in groups. They use the scale to form pieces of modelling clay with the same mass. They are then challenged to make the pieces of clay float.

Example:



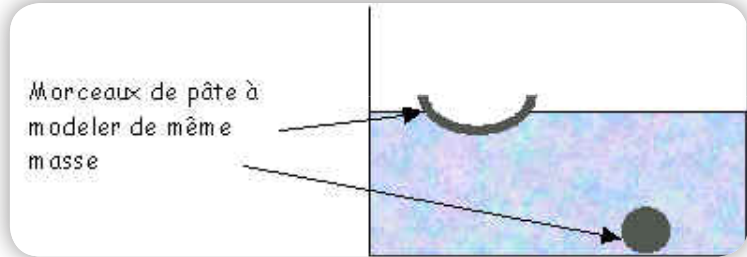
Pieces of modelling clay with the same mass



The children discuss in their groups, then as a class, to try to explain the experiment. The discussion will touch upon the space occupied by the object in the water, which varies depending on the object's shape. The concept of immersed volume can be "brought out" by modelling several shapes of different heights but identical mass, using a matrix (jam jar, for instance):

3 pieces of modelling clay of identical mass

Morceaux de pâte à modeler de même masse



Sequence 3: How an object's mass influences its floatability

two objects of the same shape (identical from the outside) but different masses do not have the same floatability. (1 session)

Objective: To compare the floatability of objects with the same shape and volume, but different masses, and begin to discuss the influence of mass.

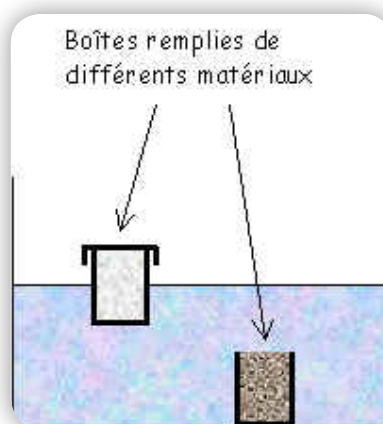
Materials (per group) :

- 7 empty camera film canisters,
- a variety of materials (sand, seeds, rice, flour, cotton, modelling clay, etc...),
- a scale,
- a plastic bag.

Procedure

First, the children are asked whether two objects of the same shape and volume but different masses float in the same way. The children observe and handle the canisters, which are empty and closed. They all float in the same manner. Then, they are asked to come up with an experiment in which they can compare the floatability of objects of the same shape, but different masses. They are shown different materials which they can use. The children discuss this in groups. They should remember to fill the canisters completely, whatever the material used. They are then asked to predict what will happen when they put the canisters in the bin, and check whether they are correct, by immersing them in the water. (A balance may be used to compare the mass of each canister).

Canisters filled with different materials



Sequence 4: How Water Influences an Object's Floatability

Water has an influence on an immersed object. It pushes the object it holds all the way to the top (1 session).

Objective: To demonstrate the action of water on an object's floating: it "pushes" the object it holds all the way to the top"

Materials for Workshop 1:

- 1 plastic bin,
- 2 0.33-L or 0.5-L plastic bottles

Materials for Workshop 2:

- 1 plastic bin,
- a fishing pole or bendable wooden stick,
- string,
- 1 0.33-L or 0.5-L plastic bottle

Materials for Workshop 3:

- 1 Roberval scale,
- sand,
- 1 rock,
- string,
- 1 plastic bin.

Procedure

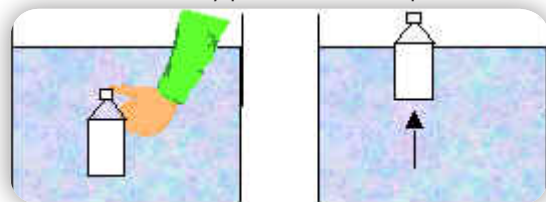
At the beginning of the session, the children are asked what they think about how water affects an object's floatability. Does water have no effect at all? Does it affect only objects that float, or all objects? Does it also affect objects that sink?

The children are offered the opportunity to work on a sequence of 3 workshops, watching the effect that water has on an object in each situation. After each workshop, the children suggest explanations.

Workshop 1

The children immerse a small empty, closed plastic bottle, then let it go.

The bottle is swiftly pushed to the top.



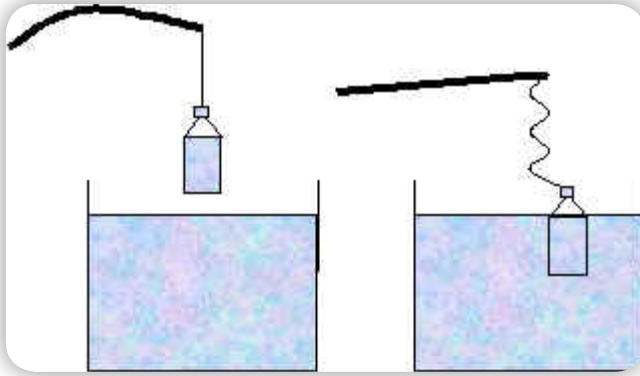
Water exerts an upward power on the object that floats.

Workshop 2

A small bottle filled with water or sand is attached to a fishing pole. When plunged into the water, the bottle noticeably "pulls less on the string".

This experiment lets students grasp the action of water on an object that is sinking.

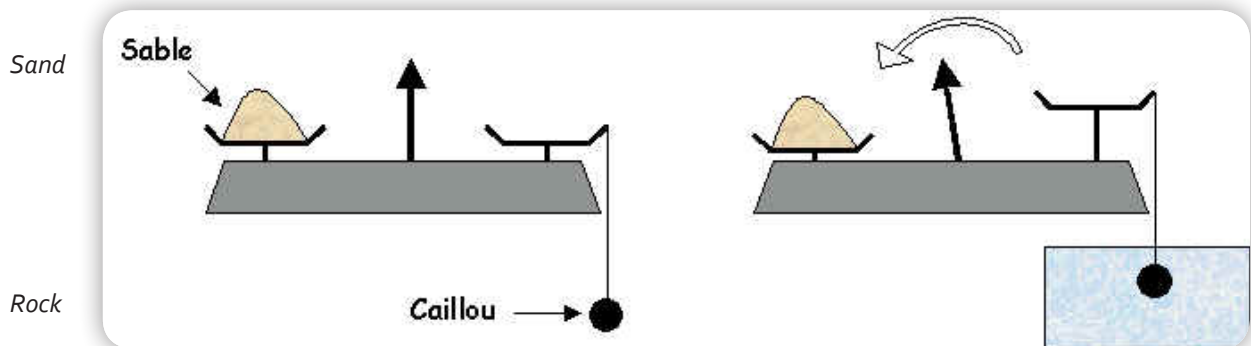




The water exerts an upward push on the bottle that is sinking.

Workshop 3

The children balance out the scale as shown in the drawing below, then watch how the balance changes when a rock is immersed in a recipient filled with water.



The water exerts an upward push on the rock that is sinking.

Note: be careful not to leave the children with the idea that the rock is lighter than the water. It is only the water's action on the rock that changes the balance.

End the session by pooling all of the comments to show the role of water on an immersed object.

Sequence 5: How the Amount of Water Influences Floatability

The amount of water does not have any influence on the floatability of an object (1 session).

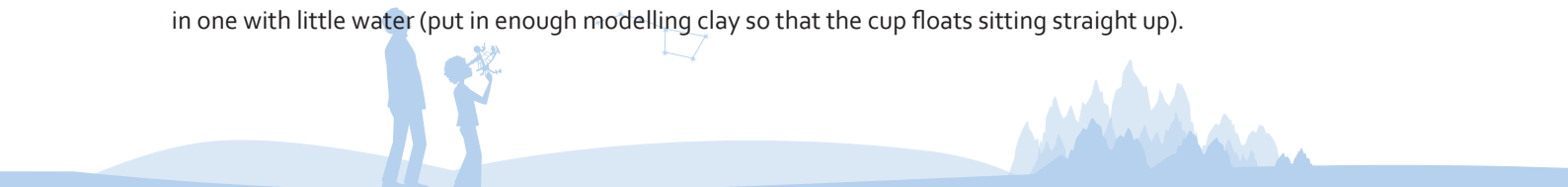
Objective: Observe the influence of the amount of water on an object's floatability.

Materials per group:

- 2 plastic cups,
- modelling clay to ballast the cups,
- 1 plastic bin.

Procedure

Initially, each child writes what how he thinks the amount of water influences floatability. After pooling the opinions through a "survey", the children are challenged to design and carry out an experiment that shows the role of the amount of water on an object that floats. The children move to the experimentation stage. They ballast the cups with modelling clay to produce an object that floats, and plunge the same cup in a bin filled with a lot of water, then in one with little water (put in enough modelling clay so that the cup floats sitting straight up).



They observe then draw the immersion level.



Floating ballasted cup

Note: the experiment can be repeated with an object that sinks

The expression "amount of water" can be replaced by "water depth".

Sequence 6: How Liquid Density Influences Floatability

Summary: An object floats more easily in saltwater than in freshwater (1 session).

Objective: Broach the concept of a liquid's density: the study will be limited to two examples, freshwater and saltwater

Target concepts: The world of matter and objects; water in everyday life.

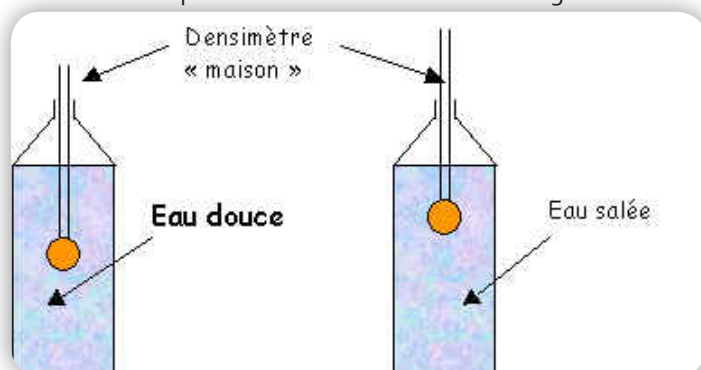
Materials per group:

- 1 plastic bottle filled with freshwater,
- 1 plastic bottle filled with saltwater,
- 1 straw,
- modelling clay.

Procedure

At the start of the session, the children give their opinion on the difference in floatability between freshwater and saltwater. After explaining what a densimeter is (here, it will be a straw ballasted with modelling clay so that it floats), the children build a densimeter in each group and plunge it into a bottle of freshwater and a bottle of saltwater.

The children depict their observations in a drawing and look for an explanation.



"Home-made" densimeter

Freshwater

Saltwater



Sequence 7: Building a Submarine

Building a submarine, meaning an object that can alternately float or sink (1 session).

Objective: Design and build an object that can alternately float or sink.

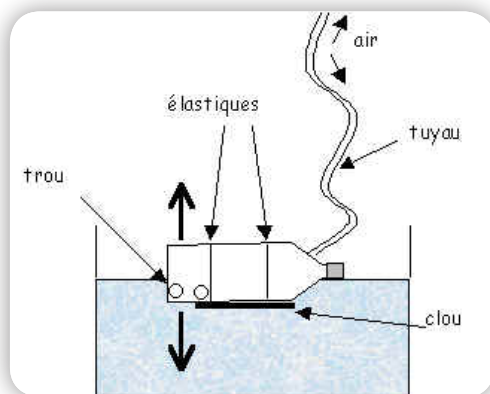
Re-establish the concepts touched upon previously.

Materials per group:

- 1 small tank at least 15 cm in depth,
- 1 0.33-L bottle mineral water,
- a piece of transparent tubing ($\varnothing = 6$ mm, $L = 40$ cm),
- 1 steel nail ($\varnothing = 5$ mm, $L = 15$ cm),
- 2 rubber bands.

Procedure

The schoolteacher announces to the class that each group will be asked to design and produce an object that alternately floats or sinks. "Do you know of any objects that can both float and sink?": submarines. After discussing how submarines work and focusing on the use of reservoir tanks that fill up with air or water (ballasts), each group comes up with its own model and moves to the design stage. Holes must be punched in the bottle so that it can fill up with water and use the tubing to bring in air. A long nail is used to ballast the plastic bottle and facilitate immersion.



air
rubber bands
tubing
Hole
nail

An experimental protocol designed by the teacher can also be suggested so that the children build a submarine model.

Going farther

During the week, you may come back to the session, asking the children to write a design notice.



Let's learn about fruit!

(ages 3 – 5)

Specific Objectives:

- To observe the fruits studied.
- To develop the five senses.
- To enrich vocabulary in relation to the activities.

The student must be capable of putting to use his observational skills to identify, name, compare and portray the fruits studied.

Materials: a fruit basket (banana, apple, pear, pineapple, nuts, lychees, orange, grapefruit, lemon, tangerines, mango, avocado, grapes, kiwi, coconut), fruit flash cards, baskets, painting, boxes.

Making Groups

Introduction to the Fruit Basket

The children are gathered in the group time corner, around their teacher and Mulotte, the classroom puppet. Today, Mulotte has brought in a gift: a magnificently-wrapped basket. "What is inside Mulotte's basket?" The students find out that the basket is filled with a whole array of fruits: a banana, a variety of apples and pears, a pineapple, nuts, an orange, a grapefruit, lemon and lime, tangerines, a mango, an avocado, different grapes, a kiwi and a coconut!

Each child will now be able to tell of his impressions. It is important to take the time to let the first perceptions and previous experiences come out.

The basket is gradually emptied out by the students, who are invited to name each fruit. This stage is fundamental in identifying the fruits that are not known to the students, or which they mix up (mango/apple, mango/grapefruit, avocado/pear, tangerine/orange). The teacher does not give the right answer immediately, but takes into account the students' prior beliefs. Later, he will come back to an exploration through the senses of the less familiar fruits, so that the children, through finer observation of the fruits, become aware of where they got mixed up.



Figure 2. Sorting the fruits by "family".

Sorting the fruits by "family"

After recalling the big event ("Mulotte's gift"), the introduction to the various fruits continues: the students place the fruits in different small baskets, by categorising them by "family" and naming each "family": apples (different colours), oranges, bananas and pears (of different kinds).

Fruit Tasting

As the sequence takes place, tasting sessions are held with the entire class, using all or part of the fruits in the basket. They are prepared in the workshop with the assistance of an adult for every group of five to six students. As they explore the tastes and smells, the students broaden their experience and redeploy what they learned from the previous tasting session. The students taste each piece of fruit, one after the other, and give their impressions (sweet/sour) or more simply speaking, "does it tingle or not?" Throughout the sequence, the teacher actually educates the students in taste, offering them a different fruit to taste each day.



Workshops

Visual Arts: Depicting the Fruits in the Basket

Draw the fruits the Mulotte brought in the basket (independent activity).

Creative Arts: fruit prints

Dip the fruits in some paint (relatively watery), then roll them on a piece of paper to produce a print of the fruit's skin, noticing the differences in texture; the aim here is to develop the sense of touch (guided activity, involving groups of four to five children).

Language: Fruit Flash cards

(The flash cards can be defined as a set of pictures showing an object or character and his name.)

This is a directed activity involving groups of six to eight children (so that each child can respond to the requests, in accordance with their level of language proficiency) carried out throughout the sequence.

During the first workshops, ask the children to place the (actual) fruits with the pictures of the same. Then, gradually, each child shall learn:

- to name the fruit held up by the adult ("show me the banana, the mango, etc.");
- to recognise the picture of the fruit designated by the adult ("now, show me the card with the apple, pear, etc.");
- to name the fruit pointed to by the adult ("tell me what this fruit is called");
- to name the fruit shown on the card ("what is the name of the fruit on this card?").

The flash cards can be produced with the students' cooperation, and available for anyone to view, or posted on a wall. The document, which shall be within reach of the students, will be conducive to "sharing" and natural "comments", independent from any stimulation from the adults.



Figure 3. Fruit flash cards.

Scientific Workshops

Preparing a Fruit-Tasting Session

This directed activity can be done with groups of five or six students, and be carried out throughout the sequence.

Prepare, with the help of an adult, a fruit-tasting session using all or some of the fruits in the basket. Here, the aim will be to develop skills in the following areas:

- motor (peeling/sharing) – the children learn about kitchen utensils and learn to choose the tool suited to the action (peeling, cutting, coring, etc.) and use it. As they cut the fruit into small pieces, the children will be able to feel the different textures involved (mango is easier to cut than apple, etc.);
- social interaction – (sharing/dividing up plates);
- science (discovering the senses, educating taste).



Making “Noise” with Fruits

- Independently, shake a variety of “noise boxes” made from boxes containing nuts and compare the sounds produced.
- Shake boxes (using the same material) containing a different number of nuts and recognise the box that contains the highest/lowest number or only one, “using nothing but your ears”, then check by opening the box (directed activity that gradually becomes an independent activity).

Let’s Sort Fruit!

Building Groups

Review of Fruit Observation and Possible Mix-Ups

Using the fruit flash cards, the teacher encourages the redeployment of the recently-learned vocabulary and ensures that the children are beginning to memorise the names of fruits and build up the corresponding mental images. He spends time on the possible mix-ups noted during the previous session: “You mixed up the apple, mango and grapefruit! Take a good look at these fruits – do you think they look like each other? What is the same? What is different?” He can then suggest a comparison of three fruits all referred to as “apples” and thereby gives the children the opportunity to identify and name the factors that led them to mix up the fruits.

Specific Objectives:

- Sort the fruit according to a variety of criteria.
- Enrich vocabulary in connection with the activities.
- Memorize the names of the fruits.

The student must be capable of:

- sorting, classifying, comparing and portraying the fruits studied;
- naming and describing the fruits;
- associating the fruit and a picture thereof.

Materials: fruits, fruit flashcards, fruit basket games, a balloon, shoeboxes, pieces of paper of different textures/colours.

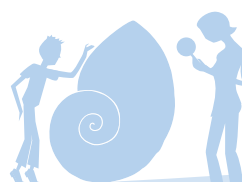


Figure 4. “Are they soft or hard?”

The group looks at the fruits: colour, size, texture, shape, weight, presence or absence of stem, etc. The group smells the fruits: “Do they all smell the same? Which has a strong smell?” The group touches them: “Are they small or hard? Can I dig my finger in easily?” The teacher can consolidate the observation by exploring the taste and smell of three fruits during a tasting session.

Determining the Fruit Sorting Criteria

The teacher asks the students to list the criteria for differentiating between the various fruits, in terms of colour, shape (large, medium, small), size (round, oval, large, small, etc.), smell (it smells, it is odour-free, etc.), texture (soft, smooth, thorny). Once that process has been completed, additional activities are suggested in small groups (scientific workshops) are offered, in accordance with the criteria listed by the students so that each student can see the use and extent of what he has just learned.



Summary of Sorting Activities

The summary of the inquiries carried out during the sorting activities (group or in workshops) can take on the form of a summary poster, produced either with the entire class, or with a small group of children.

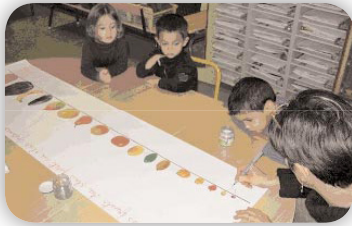


Figure 5. Summary of size-based sorting.

Workshops

Language

Fruit Flash Cards (continued)

Continue the work started previously to integrate the specific vocabulary (guided activity with groups of six to eight children).

Fruit Basket Game

The fruit basket game is designed by the teacher using fruit cards to be placed on a basket. To attach the “fruit cards” to the basket/stand, putty or Velcro may be placed both on the basket and on the back of the « fruit cards ».

During the first workshops, ask the student to match up the “fruit cards” and the actual spots in the basket. Then, gradually add other components, depending on the students’ proficiency, the skills to be implemented, the instructions and the degree of adult guidance.

- Recognising fruits: from the picture of a fruit, name the fruit, find the matching “fruit card” and place it in the fruit basket (guided activity).
- Sorting by colour: “based on a coloured ‘order form’, look for the « fruit cards » of the same colour and place them on the fruit basket (independent activity).
- Broaching quantity:
 - fill up the basket with as many fruit cards as there are spots (independently-performed activity);
 - based on an ‘order form’ where a specific quantity of fruit is drawn, for example, five apples, three pears and two mangos, produce the collection by placing the matching “fruit cards” on the fruit basket (guided activity that gradually becomes independent).

Visual Arts: Depicting the Fruits (observation drawing)

As a guided activity, in groups of six to eight children, draw fruit: choose the colour, draw the outline of the fruit, having placed it on a sheet of paper to fully view its size and shape, observe the fruit’s characteristics (stem, spots, etc.). The teacher can also note on the children’s drawings what they describe to him, “this is the apple’s stem”.

Scientific Workshops

Directed activity with groups of six to eight children, aiming to make exchange between the children more effective and generate verbalisation of the first rationale stated.

Sorting Fruits by Colour (sight)

Bring together all of the fruit of the same colour, then match each group with a label of the same colour (orange, green, yellow, brown and red). The adult takes this opportunity to have the children say the names of the fruits and colours.

Sorting Fruits by Texture (sight/touch)

Hold the fruit in one hand, run them over the palm of the hand and over the cheeks to grasp the “concepts” of hairy, rough, prickly, smooth, etc. The fruits are then classified in two categories: “smooth” and “not smooth”, each possibly being embodied by a reference material (for instance, sandpaper and a piece of velvet or satin).



To take the exploration further, a “tactile domino” can be made using materials of various textures.

Sorting Fruits by Smell (smell)

Sort the fruits according to the criteria, “smelly or not smelly?”, either “blindfolded” (if the children are willing), or using a “smell box” made of shoeboxes with the cover punctured to let “out” the smell of the fruit (whole, chopped, citrus peels, etc.), without showing what it is.

The teacher may take the first classification further (during the tasting sessions, for example, by repeating the experiment several times, so that the children memorise the smells « specific » to certain very characteristic fruits (oranges, bananas, tangerines, etc.).

Sorting Fruits by Shape (sight/touch)

Compare the shape of the fruit with that of a ball: “Does it roll like a ball or not?”. The first classification can be enhanced by an introduction to geometric shapes and volumes.

Sorting Fruits by Size (sight/touch)

Rank the fruits “from the smallest to the largest”. As an extension to the experiment, teach the children about measuring length (paper strips, string, rulers, etc.).

Sorting Fruits by Mass (sight/touch)

Rank the fruits from “heaviest to lightest”. As an extension to the experiment, have the children use the tools to measure mass (various types of scales).

Let’s Compare Fruits!

Building Groups

Observing Fruit Insides

“We have looked at the outside of fruits.... And now, let’s look at the inside of all these fruits! In your opinion, what are we going to find?”

The students describe the inside of the fruits with which they are familiar and imagine the others, then check their hypotheses by opening the fruits. They look at the various fruit insides and use their own words to express what they see, smell and feel (soft mango and lychees, hard apples and coconut, with seeds or pits, citrus fruits in wedges, etc.). By opening the coconut (using a hammer held by an adult), the children will be able to experience how hard it is and learn of the existence of “coconut water”.

Specific Objectives:

- To look at fruit chunks.
- To develop the senses.
- To enrich vocabulary in relation to the activities.
- To distinguish quantities.
- To observe the changes that arise when fruits are cooked.
- To learn about another form of writing: recipes.

Upon completing the module, the student should be able to:

- put his sense of observation to use to identify, name, compare and portray the fruit chunks;
- match a whole fruit with the appropriate fruit chunk;
- compare raw and cooked fruit;
- produce and compare collections;
- put a series of pictures in the right order;
- choose the tool best suited to the target action.

Materials: fruits (including apples), knives (round-tipped), plates, vegetable peelers, corers, pitters, mashers, forks, spoons, a hammer, sugar, the recipe for apple sauce, plaster, paint, fruit flash cards, and the fruit basket game





Back to the Raw Fruit Tasting

The teacher continues the work carried out since the beginning of the sequence in the “preparing a fruit-tasting session” (guided activity with groups of six to eight children) and during group tasting times (directed group activity).

Each child is given a plate in which there are pieces of each fruit, which he tries to recognise before eating them, thereby redeploying what he has learned about the characteristics of each fruit, by using his senses (colour, odour, appearance and texture).

“Can all fruit peels be eaten? How can I remove the peel if I do not want to (or should not) eat it? What tools can I use to peel? Can fruits be eaten whole? How can they be cut? What kinds of utensils should be used? Do all fruits taste the same?”

The teacher fosters further learning by pooling the experiences reported throughout the sequence and, in particular, exploring the tastes and smells of the fruits during the tasting sessions. The students redeploy what they have learned, both in terms of language and science, as a result of the inquiry-based sensory activities in which they have engaged.

The experiment can be taken further by making a fruit salad.

Comparing Raw and Cooked Fruits

An entire day will be dedicated to making apple sauce (learning the recipe, implementing it, cooking and eating).

The teacher posts the recipe for apple sauce and the class as a whole broaches this new form of text.



Figure 9. Applesauce recipe.

The students will:

- tell what the purpose is;
- suggest how the recipe should be carried out (“What are we going to do?”);
- describe the illustrations, verbalise the actions (“How should we proceed?”);
- list the materials and ingredients required (“What do we need?”).

The applesauce is produced as a guided activity, either in a group setting (preparing apples and adding other ingredients), or in small groups (cooking, mashing).

These activities give the children the opportunity to explore the world of matter (cutting, transferring, mixing) and observing how matter is changed when cooked (raw fruits, cooked fruits), but also to become aware of the risks in their everyday environment (safety education).

The tasting is, first and foremost, a relaxed time for learning, making it possible to continue the work carried out up to that point, by comparing the cooked and raw fruits (textures, flavours, smells, colours, etc.). It is also the time for learning basic hygiene rules (washing the hands, keeping tables clean, etc.).



Workshops

Language

Fruit Flash Cards (continued)

Work from pictures alone, without using the actual fruits to help out (directed activity with groups of six to eight children).

Fruit Basket Game (continued)

Use the materials to match the cut up fruit card with the whole fruit card, then put them in the fruit basket.

Foster independent redeployment of lessons learned, both in terms of language and science:

- using “order forms” referring to the different concepts broached during the previous sessions (colour, quantity, size, texture), the children are asked to find “fruit maps” that match the “orders” and place them on the fruit basket (independent activity);
- one child reads out the order, the other fills it, the first one checks the second’s work and then they change roles (tandem, independent activity).



Figure 10. Drawings from observation of cut fruit.

Visual Arts: Portraying Cut Fruit (drawing from observation)

Drawing cut fruit: choosing the colour, drawing the outline of the fruit set on a sheet of paper to properly determine its size and shape, observe the characteristics of the inside of the fruit (seeds, pits, quarters, etc.). The teacher can also write down what the children state on their drawing: “This is the mango pit” (guided activity with groups of six to eight children).

Creative Arts: Cut Fruit Prints

Make fruit prints, either with plaster, or with a piece of fabric dipped in paint, then use the prints to recognise the fruit (directed activity, with groups of four to five students).

Scientific Workshops: Making and Eating Applesauce

Preparing the Apples

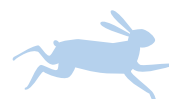
Beforehand, the teacher peels the fruits so that the children have only to cut them up (with a round-tipped knife), core them, pour them into a pot and add the ingredients – water, sugar (guided group activity).



Figure 11a. Cut the apples.

Cooking the Apples

The students come up with hypotheses about what is likely to happen during the session. Then, in small groups and with an adult, they look at what is actually happening (heat, bubbles at the surface, colour of apples, texture, etc.) and discuss the hazards present in the kitchen – safety education (directed activity with groups of four to five children).



Making Applesauce

The children handle a variety of kitchen utensils (masher, forks, spoons, round-tipped knives) to crush, mash, smooth out the mixture and remove the pieces of fruit from it.

The activity is carried out by trial and error and imitation; it allows the children to find the best way to use the tool selected and learn how it works. The teacher invites the students to look for the most effective kitchen utensil for crushing the cooked apples – the fork is better than the spoon, etc., but the masher is the best choice of all (directed activity with groups of six to eight children).

Applesauce Tasting

The students talk about their experience in terms of textures and flavours. The tasting can be enhanced by comparing a cooked apple with a raw one, then between the class' applesauce and processed applesauce (directed group activity).



Figure 11b. Add ingredients to pieces in bowl.



Figure 11c. Mash the cooked apples.

Let's Take a Look Back!

The language learning opportunities present throughout the sequence, in the various sensory inquiry activities, need to be maintained regularly, over a relatively long period of time, to ensure that the new language abilities are lastingly integrated.

During the redeployment sessions, the teacher may use:

- natural situations (snack time, parties, birthday parties, etc. where new fruits will be brought in and the already-familiar fruit served fresh or as a fruit salad, jam or in stewed form, etc.);
- the sequence of the seasons, to establish a "fruit calendar" throughout the year;
- events such as the Week of Taste;
- an extension activity can be implemented along with the "making fruit juice for 4- and 5-year-olds" session)
- designing a garden in the school courtyard or in a "seed and plant" area in the classroom.

The following instructional tools can also be used.



Individual Worksheets

The worksheets allow the teacher to assess what the students have learned



Figure 12a. Independent activity:
"I can find the cut fruit card and glue it onto the sheet next to the whole fruit"

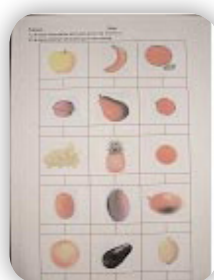


Figure 12b. Directed activity:
"I know how to recognise the fruits mentioned to me and I know how to name the fruits I am shown".



Figures 12c and 12d. Independent activity: "I know how to read an order", then, "I know how to fill the basket, according to the "order slip".

Group Summary Charts

The charts are made by the all of the students as a group, then posted in the classroom, within the students' reach and at their eye level. They foster exchange and naturally stir comments from students, amongst themselves. They supply situations for redeploying lessons in both language and science, learned during the inquiry-based activities carried out throughout the sequence.



Figure 13. Group activity: "I know how to match the whole fruit with its name, the cut fruit and what is inside the fruit".

Materials Produced During a Sequence

The materials are produced in cooperation with the students and are available to them in the classroom's "science corner".



Figure 14. Fruit basket:
"I know how to name the fruits that I put in the basket".



Figure 15. Dominos :
"I know how to match a whole fruit with a cut fruit".



Figure 16. Lottery:
"I know how to match two identical pictures".

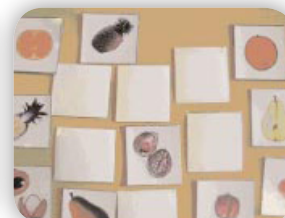


Figure 17. Memory:
"I know how to memorise where fruits lie in pairs".



Acorn Germination (ages 3-5)

Authors: E. Villard (Ecole maternelle Davayé, IEN Mâcon 4, 9 rue Flacé 71000 Macon Saône-et-Loire), J.P Chauvin (École maternelle Varennes-Les-Mâcon, IEN Mâcon 4, 9 rue Flacé 71000 Macon Saône-et-Loire), N. Bonsirven (IUFM de Bordeaux, 49 rue de l'école normale 33200 Bordeaux)

Summary: The children study germination on acorns gathered in the forest, then sowed either in a bucket of stones or in a bucket of soil.

Objective: To realise that germination is a phenomenon that can be found in nature, without human intervention.

Target concepts: Observation of characteristics of living organisms

Duration: Around 6 sessions.

Materials: Acorns, water, watering can, soil, rocks, buckets.

Problem situation: What do acorns turn into?

Going to gather acorns in the forest – Group session

Note the changes compared with our last autumn outing.

The children discover acorns:

- "What are these?"
- "Are they all the same?"
- "Where are they found?"
- "Why are they here?"

Anything under the oak trees can be picked up.

Classifying what we have gathered – in small groups

The children all empty out their bags and place their content on four large white boxes:

moss	acorns	leaves	other
------	--------	--------	-------

Observing the acorns – in small groups

Description

- "They are brown."
- "Some of them have something coming out of them."
- "Others are broken."
- "They are closed."
- "This one is rotten."
- "There is a little bit of red."
- "They have a tail."

They are divided into two families

The ones with something coming out of them	The others
--	------------

lexicon: the thing coming out of the acorn is known as a shoot.





Two acorns, one with and one without a shoot, are drawn

Why do certain acorns have a shoot?

Why do certain acorns have a shoot?

- "That is what attached them to the tree".
- "They are going to grow."
- "They are roots."
- "It's for growing into the soil."
- "It's for making flowers."

Why do other ones not have them?

- "They lost their tail."
- "They lost their skin."
- "They are rotten."
- "They are broken."

A Brief History of Acorns

Where do they come from? Where did we find them?

- "They come from the forest above our school."
- "We found them on the ground."
- "They were in the moss."
- "They were in the trees."
- "They were over by the oak trees."

What is the use of acorns?

- "They are used to be gathered."
- "They are used to look nice."
- "They are used as animal food."
- "They are used to be looked at."
- "They are used to make trees."
- "They have no use."
- "They can be made into flowers."
- "It's going to become a tree in the classroom."
- "They are used to grow to make a tree or flowers or rose bushes."

How can we tell if acorns can grow?

Hypotheses set forth by the children

- "You have to put them in a bucket."
- "You have to put in soil."
- "You have to put them in the rocks."
- "You have to put in water."

What materials are required to carry out this experiment?

- "soil or rocks",
- "a bucket",
- "a shovel",
- "a watering can".

It is decided that some of the acorns should be put in the bucket of rocks, and others in the bucket of soil.



Experiment implementation

Carrying out the experiment.

Drawing – See results below.

Imagining what is going to happen.

Observations after two weeks

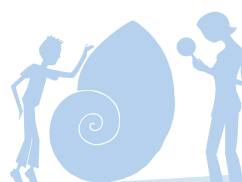
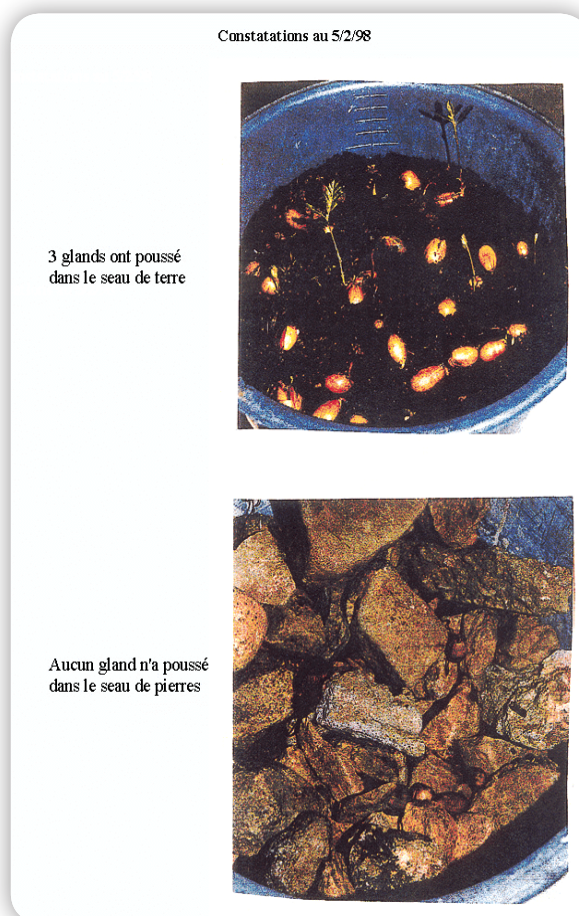
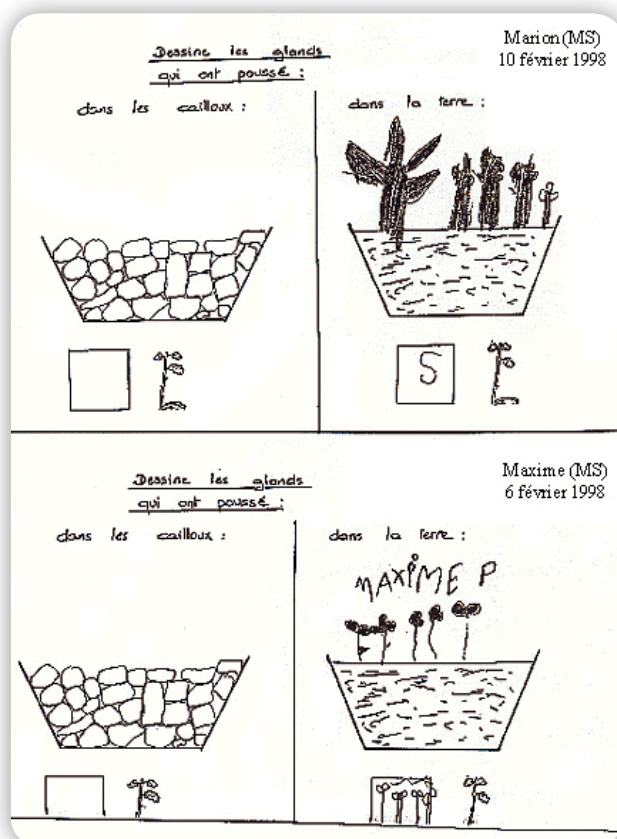
Observation and verbal description

- "The acorns in the bucket of stones didn't grow."
- "Maybe we didn't wait long enough."
- "It's a little too dry."
- "The stones are too big."
- "The acorns in the other bucket grew."
- "Some look the same."
- "There are leaves."

The children draw what they see, making note of the date and number of acorns that grew leaves. See results below.

The class makes a group poster board, with photographs.

Student production



The Hourglass Race

(ages 3-4)

Authors: Group work carried out under JP Chauvin, J.P Dumont and E. Villard (Ecole maternelle Davayé, IEN Mâcon 4, 9 rue Flacé, 71000 Macon Saône-et-Loire)

Summary: Over the course of the 8 sessions hereafter, the children, study, use, produce and compared hourglasses. They broach the concepts of time and speed.

Objective: I am familiar with and have a feeling for the concepts of “faster than”, “slower than”, “first-place finisher”, “last-place finisher”, “at the same time as”.

Target concepts: Learning about the world of objects: using various technical objects in functional situations.

Duration: 145 minutes in 9 sessions

Materials:

Learning About Hourglasses:

1) Introduction to the concept of flow

For the class:

- punched bottles,
- water
- hand rags.

2) The hourglass as an object

For the class:

- an hourglass made with two plastic bottles filled with semolina,
- an hourglass identical to that above, but with non-punched caps

Compare the two hourglass' flow time

For each child:

- two hourglasses per child:
- one red 🕒 with a lot of semolina,
- one green 🕒 with a little semolina,
- two boxes symbolising the two hourglasses

Compare the time required for the sand to run out in the three hourglasses

For each child:

- 3 hourglasses and 3 symbol boxes: 🕒 🕒 🕒

How can the time required for the sand to run out be changed?

For each child:

- 3 hourglasses for the 4-year-olds, 2 hourglasses for the 3-year-olds,
- a worksheet to record the final order

How are hourglasses filled?

For the class:

- semolina, empty hourglasses, funnels

For each child:

- 3 hourglasses for the 4-year-olds,
- 2 hourglasses for the 3-year-olds,
- a results chart

Predict the order in which the hourglasses will finish the race, in accordance with semolina volumes

For each child:

- 3 hourglasses,
- semolina,
- funnels,
- small jars,
- filling cards,
- results charts.

Set up three hourglasses, comparing them two by two.

For each child:

- 3 hourglasses containing nearly-identical sand volumes
- a results chart.

Animals at the Racecourse

Duration: 20 minutes

Objective: I am familiar with and have a feeling for the concepts of "faster than", "slower than", "first-place finisher", "last-place finisher", "at the same time as".

Class Organisation:

Game in game room

Four groups of children mime four different types of animals: rabbits, snakes, monkeys and frogs. Instruction: "When I sound the signal, each animal will move as quickly as possible to the river, moving like real animals".

At the finishing line, the first-, second-, third- and last-place finishers are recorded.

An explanation is given as to why the monkeys are always the fastest and the snakes the slowest: the former run, while the latter crawl.

The same game is repeated, but all of the animals have to reach the river at the same time.

Learning about the Hourglass as an Object

Pedagogical approach:

1) Broaching the concept of flow

Non-directed play in the water tank with punctured bottles.

Duration: 10 min in very small groups

Materials for the class:

- punctured bottles
- water
- and hand rags.

2) The hourglass as an object

The teacher shows an hourglass to the students, who watch and comment.



Duration: 15 min - group –

Materials for the class:

- an hourglass made with two semolina-filled plastic bottles,
- an hourglass identical to the previous one, but with a non-punctured cap

What is happening? Why does the sand flow in one and not the other?

Comments:

- for the 3-year-olds, use small mineral water bottles
- semolina flows more steadily than sand

3) Undirected handling of several hourglasses filled to different levels

Duration: 10 min -

Class organisation: small groups

Materials for the class:

- hourglasses

4) Observation and Drawing

Duration: 5 min

Class organisation: individual work

What can I do while the sand runs out in the hourglass?

Concept: the time required for the sand to run out (T) can be a duration that I can measure intuitively.

1) Racing for Rings

Duration: 15 min

Class Organisation: group

Instruction: pick up as many rings as possible during allotted time (T)

The person with the greatest number of rings is the winner.

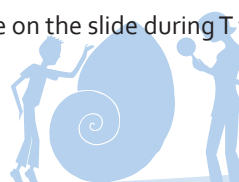
2) the slide

How many times can I go down the slide during the allotted time (T)?

Duration: 15 min

Class organisation: small groups -

2.1 –Each student needs to announce the number of turns he can take on the slide during T time





The purpose is to anticipate the result.

2.2 – The game is played again several times. The number of turns is always around the same for a single student.

3) The children watch how far the “seconds” hand on the clock can go as the hourglass runs out.

Comparing the time required for the sand to run out in two hourglasses

Duration: 20 min

Classroom organisation: individual work –

Materials:

For each child:

two hourglasses per child:

- one red ⌚ with a large amount of semolina,
- one green ⌚ with a small amount of semolina

Two boxes symbolising the two hourglasses

Instruction: “Which hourglass empties the quickest?”

Comment: all of the hourglasses used have a hole of approximately the same diameter.

Written record: group results chart

1	2
⌚	⌚
⌚	⌚
⌚	⌚
⌚	⌚

1 = hourglass that runs out first

2 = hourglass that runs out second

Why is the red hourglass the fastest?

What happened in the third experiment?

The experiment is repeated as a group.

Conclusion

To compare the two hourglasses, they need to be turned over at the same time.

This is a difficult concept to understand, even for 4-year-olds



Compare the time required for three hourglasses to run out




For the 4-year-olds only -

Duration: 20 min

Class organisation: small groups of four students –

Materials:

For each child:

3 hourglasses and 3 symbol boxes:   













Instruction: arrange the glasses in order, from fastest to slowest.

Three students each have an hourglass and must turn it over.

The fourth child writes down the results.

The experiment is repeated three times, with the students changing roles.

Written record: example – per group of four children

1	2	3
		
		
		
		

Why did the red hourglass not always empty out first?

- Because they do not all run out the same.
- 'Cuz I'm the fastest.
- Because there was no more

Conclusion: the 3 hourglasses have to be turned over at the same time

Group summary

The group decides to always use the same method to compare the hourglasses:

- one "measuring" student with no hourglass counts to 3.
- on 3, the other students in the group turn over the hourglasses.
- when one hourglass has run out, the person who turned it over raises his hand and says "Stop!", along with the name of the his hourglass' colour, for instance: "Stop! Red!"
- the "measurer" notes the order in which the hourglasses come in.

The experiment is repeated.

Is this finishing order always the same?





How can the time required for an hourglass to run out be modified?

Class organisation: Small groups

Materials:

For each child:

- 3 hourglasses for the 4-year-olds, 2 hourglasses for the 3-year-olds,
- A sheet to record the finishing order

Instruction 1: Arrange the hourglasses from fastest to slowest.

Instruction 2: I want the slowest one to become the fastest.

All together, the suggestions from the various groups are studied.

"we can take semolina from the slowest hourglass so that it runs out more quickly".

In very small groups, the suggestion is tested and results recorded.

As a group, it is concluded that:

"The more semolina there is, the slower the hourglass empties out."

VII – How is an hourglass filled?

Materials for the class:

Semolina, empty hourglasses, funnels

1) how can an hourglass be filled?

Individual undirected trial. Assistance from instructor.

Group sharing: the children dictate to the instructor how he should fill the hourglass.

To fill an hourglass, you need to:

1. open the two bottles
2. fill one bottle with the funnel
3. screw on the cap
4. screw the cap on the second bottle

2) How can an hourglass be filled so that it empties out more slowly or more quickly?

Duration: 20 min

Class organisation: small groups

Materials:

For each child:

- 3 hourglasses for the 4-year-olds,
- 2 hourglasses for the 3-year-olds,
- a results chart



Instruction: Fill up the 2 or 3 hourglasses to achieve the results provided in the chart.

Check and record the results.

Sample chart provided for "4-year-olds"

1 ⌚	2 ⌚	3 ⌚
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Predicting order of hourglass finish according to semolina volumes

Duration: 20 min

Class organisation: Small groups – 4-year-olds only

Materials for each child:

- 3 hourglasses,
- semolina ,
- funnels ,
- small jars,
- filling level instructions,
- results charts

Instruction: Fill the hourglasses as indicated on the filling level instructions (1, 2 or 3 jars of semolina) O = one jar of semolina

- Example:

oo > ⌚	ooo > ⌚	o > ⌚
--------	---------	-------

Write down the results you think you will achieve on the worksheet. Se sample below.

Perform the experiment.

Write down the actual results.

Compare the expected results with those on the worksheet.

Comment: one group ended up with different results. The experiment was repeated with the entire class. It turned out that the hourglasses had not been properly filled.

Sample worksheet

Group: Chloé, Marion and Maureen

I fill all of the hourglasses correctly and arrange them from the fastest to the slowest

The results I expect:

1st ⌚	2nd ⌚	3rd ⌚
O	o o	o o o

The actual results





8

1st	2nd	3rd
-	-	-

Arrange three hourglasses and compare them two by two

Duration: 15 min

Class organisation: Individual work

Materials for each child:

- 3 hourglasses containing nearly-identical semolina volumes
- A results chart

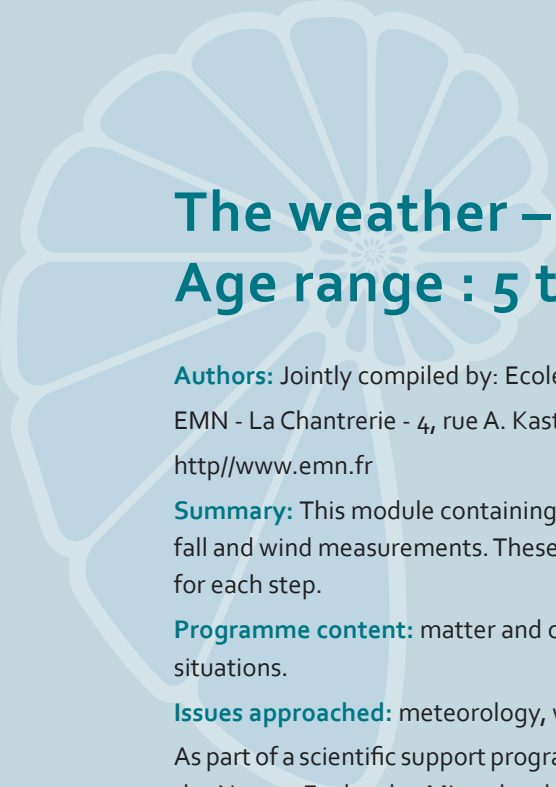
Instruction: "You have three hourglasses. You are allowed to turn over two at a time".

Put them in order, from the fastest to the slowest!"

Sharing and Conclusion

If the red hourglass runs out more quickly than the blue one,
and if the green one runs out more quickly than the red one,
then the white hourglass runs out more quickly than the blue one.





The weather – Meteorology

Age range : 5 to 7

Authors: Jointly compiled by: Ecole des Mines de Nantes and primary school teachers

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<http://www.emn.fr>

Summary: This module containing 5 sequences aims at setting up a weather station to record temperature, rain-fall and wind measurements. These three topics are approached in succession and measuring « apparatus » is built for each step.

Programme content: matter and objects: water in our daily lives, use of a thermometer in a few chosen everyday situations.

Issues approached: meteorology, water, air, temperature measurement.

As part of a scientific support programme to La Main à la Pâte, with primary schools in the Loire-Atlantique Region, the Nantes Ecoles des Mines has been working in conjunction with teachers, since school year 1996, to produce toolkits containing all of the equipment needed to perform experiments in the classroom, along with a guiding document.

For each topic covered, the document describes a range of experiments and suggests a general sequence of events, list of equipment used and list of required knowledge from the National School Board ("Inspection générale") related to the topic of study. This can be a foundation for setting up science activities, in line with the La Main à la Pâte approach. The general sequence of events is provided for guidance purposes only. Intentionally, the document does not elaborate on the pedagogical approach to be adopted, rightfully leaving it to the initiative of the teacher – the specialist.

This five-sequence module is derived from the back-up documents provided with the activity packs.

Material :

For 7 groups of 4 pupils :

14 alcohol thermometers (-20°C to 50°C)

ink or red food colouring

7 glass flasks (60 ml) with airtight stoppers

20 thin straws, clear or light-coloured

7 plastic bowls

1 measuring glass (+ 6 to be brought from home)

plastic film

1 direction compass

string

7 ping-pong balls

7 wooden sticks (w= 0.5 cm, L= 30 cm)

7 wooden supports (w= 3 cm, L= 30 cm, H= 0.5 cm)

stiff paper

20 drawing pins

14 nails (w= 1 mm, l= 5 cm)

marking tape

1 hairdryer (to be brought from home)

Sequence 1 - Initial Questioning

Initial questioning, class discussion on the subject of the weather. (1 session)

Initial questioning (session 1)

Class discussion with the teacher who notes on the board the replies put forward by pupils in answer to the questions:

What is a weather forecast? What is its purpose? Cite some phenomena of weather. What elements are involved? How are they measured? Do you know of any measuring instruments?

- the expressions put forward should include sun, rain, wind, temperature, weather forecast, etc.
- The teacher then announces that the class is to build a small weather station, to obtain information on the school's weather. The teacher asks the pupils what they will need to build this station. At the end of the session, the children are asked to bring a weather report cut out of a newspaper for their next session.

Sequence 2 - Thermometers and temperature (3 sessions)

Pupils observe different thermometers and the teacher asks questions on how they function. The pupils explain different ways to cause the liquid to rise. Building a thermometer and expansion test. The pupils calibrate the thermometer built during the previous session, using three temperature ranges: cold, warm, hot.

Session 1: Study of thermometers and introduction to the notion of expansion

Objective :

Using an everyday object such as a thermometer, to describe and understand its functioning, to use appropriate vocabulary.

To understand why the liquid rises in the thin tube; to introduce pupils to the notion of expansion..

Material :

Per group:

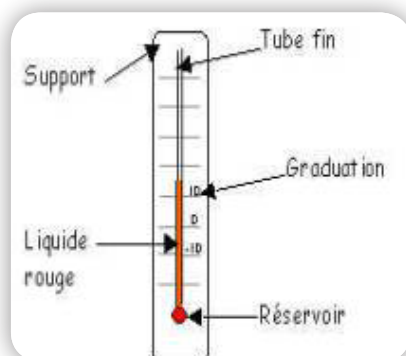
one thermometer (children will be asked to bring one from home to make comparisons – mercury thermometers must not be allowed),

hot water,

wool, etc...

For the class:

one hairdryer.



Thin tube
Holder
Graduation
red liquid
Reservoir



Procedure:

- Study of thermometers

The teacher gives a description of thermometers: what are they used for? What is the difference between them?

Initial pooling of observations: how many different parts have you noticed? The teacher draws a simple thermometer on the board, only showing the important parts, and writes a key: holder, thin tube, red liquid (coloured alcohol), reservoir, graduation.

This diagram is copied by pupils.

Introduction to the notion of expansion

The purpose of this section is find out how to cause the liquid to rise inside the thermometer. Class challenge: «think up an experiment to make the liquid rise in the thermometer ». Each pupil writes down his/her idea which is then tested within the group.

Various suggestions:

- place it in the sun
- heat it in one's hands (without specifying which part)
- use hot water
- blow on it (with a hairdryer)
- wrap it in wool, etc.

Pooling of suggestions: Which idea worked ? which did not ? What is the connection between temperature variation and the supply of heat ? It will be simply observed that when the thermometer is placed next to a warm object, the temperature rises and conversely, when the thermometer is placed next to a cold object, the temperature drops.

Make pupils specify: which is the part that is heated? Does it make any difference if the source of heat (glass of hot water) is placed level with the reservoir? next to the thin tube ? or at the top of the tube ?

Pupils repeat their experiments to determine whether thermometer reaction is related to the part which is heated.

Conclusion, after testing for 10 min: the thermometer does not react in the same manner for each part that is heated. It is the reservoir which must be heated, that is to say the liquid.

Then at the end of the session, collect all the questions raised by children subsequent to their observations of the thermometer: For example:

What happens to the thermometer when the level of liquid cannot fall any lower?

What makes the liquid rise or fall?

How does it know whether it is cold or hot?

What does "°C" mean?

What is this red liquid, in general?

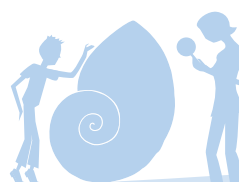
The most recurrent question is definitely the second one: «what makes it move upwards or downwards? » it is therefore decided to work on this question. The class agrees on which type of thermometer to use.

Session 2: Notion of expansion; building a thermometer

Objective: Demonstrate the expansion of liquids when they are heated.

Material:

- Per group:
- one thermometer,
- red ink,
- 60 ml glass flask with airtight stopper,
- a thin straw, clear or light-coloured,
- plastic bowl.

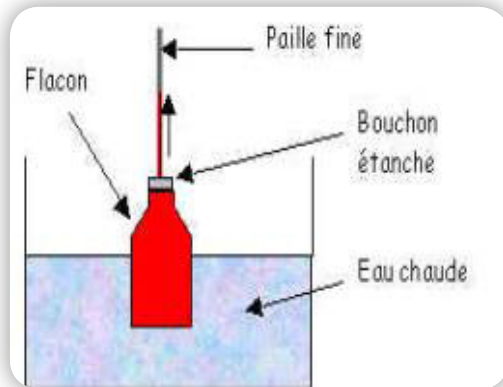


Procedure:

- First recall the conclusion previously reached: the liquid rises in the thermometer when the reservoir is heated. The thermometer makes use of a property of liquids when they are heated: what happens? If the liquid rises, is it because there is more liquid? If it is recognized that there has been no exchange of matter (the liquid being in a «closed container »), the reply is No. But then, why?

- Liquids take up more room when they are heated, they are said to expand. The teacher asks pupils to suggest an experiment to prove this.

Suggestion: the flask filled with coloured water and with a straw plunged through the stopper is placed in a bowl of very hot water. The level of water in the straw at room temperature is previously recorded. The water rises inside the straw within a few minutes. Our thermometer works !



Thin straw
Flask
Airtight stopper
hot water

What is missing in this thermometer ? Graduations, so that we can read the temperature.

The problem which remains therefore concerns its calibration. The pupils are asked to find out at home how this thermometer can be graduated.

Going further:

The session can be extended by showing that with a source of cold (ice cubes) the liquid falls.

Session 3: Calibrating the thermometer

Objective: Understanding the notion of graduation, finding the connection between temperature and the level of liquid in the thin tube.

Material - Per group:

- one control thermometer,
- the thermometer previously made,
- some ice,
- hot water

Procedure:

Has anyone found a way of graduating the thermometer ?

If so, test it.

If not, the teacher sets pupils on the right track: all that is needed is to compare with a real thermometer and to mark on our own the three ranges of cold, warm and hot. To determine these ranges, the pupils must successively dip the flask in water at different temperatures (for example, cold: 0°C to 12°C, warm: 12°C to 25°C, hot: 25°C to 35°C) and mark the corresponding level of liquid

Sequence 3 - Rain – Building a rain gauge

Summary: Building a device to collect rainwater followed by experimental stage. Discussion on the choice of rain gauge. (1 session)

Objective

Devise and use of an instrument to measure rainfall.

Material :

Per group of 4:

one plastic bottle,

plastic film,

one measuring glass,

a rubber band.

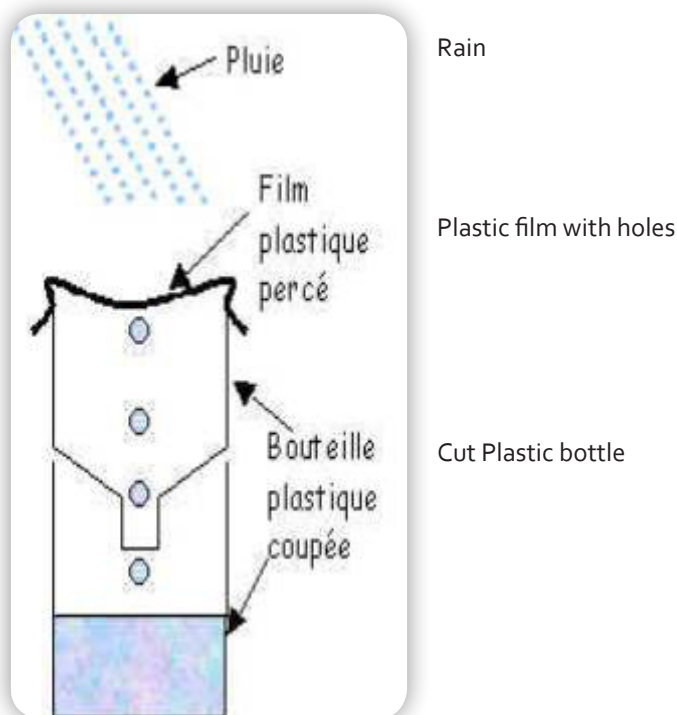
Procedure

- Recall of the different states of water: in general how do we call what falls from the sky ? Give examples: rain, snow, hail, etc. They are called precipitations.

What happens to snow when it has fallen to the ground? It melts and turns to water. The same thing happens to hail.

How does one set about measuring the quantity of water which falls from the sky? With a measuring instrument called a rain gauge.

Then challenge the class: how can we make a rain gauge using a bottle?



It can be suggested to cover the bottle (top part sectioned) or container with a plastic film pierced with a hole and held in place with a rubber band. The volume of water collected is quantified using a measuring glass.





sequence 4 - The wind

Summary: The wind - observations and definition. Study on the direction of the wind using a windsock. Characterizing the action of the wind. Building a weathervane and an anemometer (3 sessions).

Session 1: Description of the wind; observation of the effects caused by the wind; wind direction

1) Description of the wind

Objective

To describe and define the wind; on the basis of observations made, to determine which parameters can be used to characterize the wind.

Material :

Per group of 4:

various plastic bags,
paper (light material).

For the class:

hairdryer or fan.

Procedure

- Class discussion:

What is the wind ? Group together all the representations made by pupils.

How can we create wind ? By blowing, with a hairdryer, etc.

What are the effects of the wind (if possible choose a windy day !)? Otherwise conduct tests in classes using plastic bags, paper...

- A joint effort is then made to find a definition. In their exercise books each pupil must continue the sentence : "The wind is... ". Followed by the class definition: «It is air in movement ».

- Then ask how we could characterize the day's wind. What makes it different from yesterday's wind ? Firstly, its force or its speed (both are connected), . Secondly, its direction. The class will endeavour to measure these two parameters.

2) Wind direction

Objective

To devise and use an instrument which determines the direction of the wind.

Material :

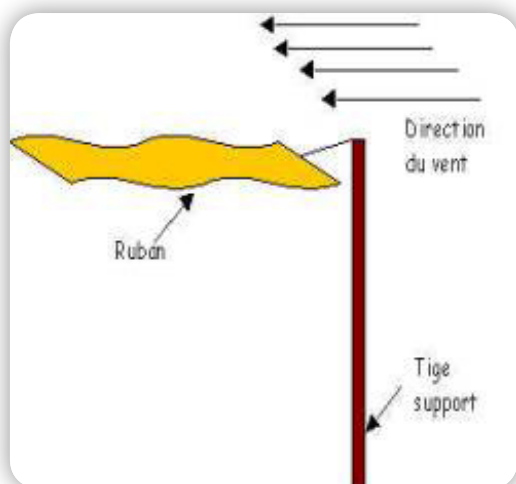
Per group of 4:

tape, approximately 30 cm in length,
string and a stake measuring 30 cm,
one drawing pin.

Procedure

After fixing the tape to a stake, (which can be compared with a windsock) the children are asked to show from which direction the wind is blowing.





Direction of the wind

Tape

Stake

This activity is conducted outdoors and the children can move around if there is not enough wind. The direction of the wind is identified using surrounding school landmarks (or using a compass).

Session 2 : The action of the wind

Objective

To characterize the action of the wind (or its force) and to find a means of measuring the wind.

Material :

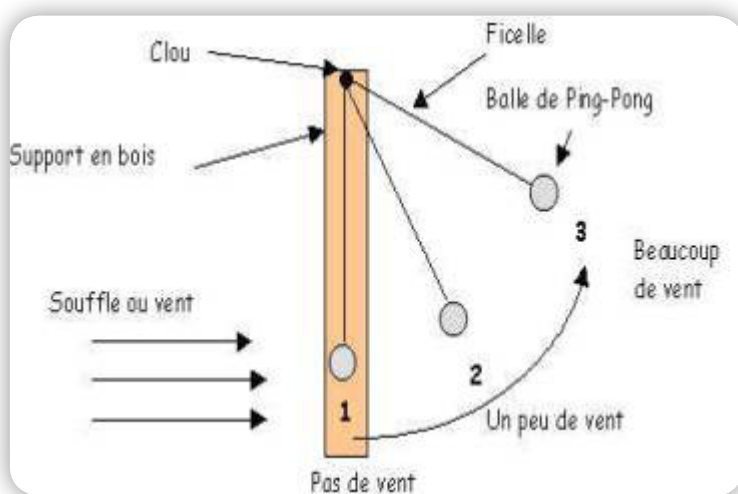
- Per group of 4:
- some string (30 cm),
- a ping-pong ball,
- a wooden stake,
- nails.

Procedure

Discuss the action of the wind on the basis of daily observations: what happens when there is a great deal of wind? (doors bang, hats fly away, etc.)

Ask pupils if they know of a simple way to measure the action or the speed of the wind.

Depending upon their suggestions, the teacher distributes the necessary material and asks the pupils to show the effects of the wind using the model described below for example. The following is then observed:



String

Nail

Ping-Pong ball

Wooden stake

Very windy

Direction

in which wind
is blowing

Some wind

No wind





The session is completed by specifying that this principle will be used to measure the action of the wind.

Going further:

Use of the Beaufort scale to measure the action (or force) of the wind. The wind is also used as energy: windmills, sailing boats, wind turbines, etc.

Session 3 : Building a weathervane and an anemometer

- cf. La science by J. HANN, éditions SEUIL

Sequence 5 – Observations and measurements – Setting up a weather station

List of instruments available for taking weather measurements.

On the completion of this module, draw up a list of instruments which we now have available to take weather measurements:

- a thermometer to measure the temperature
- a rain gauge to measure the quantity of rainfall
- a windsock or a weathervane to determine the direction of the wind
- an anemometer to measure the speed of the wind

There are other, more complex, parameters which pupils may have read in weather forecasts: air pressure in particular which is measured with a barometer

A class rotation system now needs to be set up to record this data regularly throughout the year, graphs may be plotted and conclusions drawn.

Books to consult:

- MEGA EXPERIENCES (Nathan)
- LA SCIENCE by J.HANN (Seuil)
- 100 expériences faciles à réaliser (Nathan)



consortium members



Credits


Graphic design:
www.lezard-graphique.net - 2010

Flags icons:
www.IconDrawer.com



Fibonacci Picture:
 Stefano Bolognini

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